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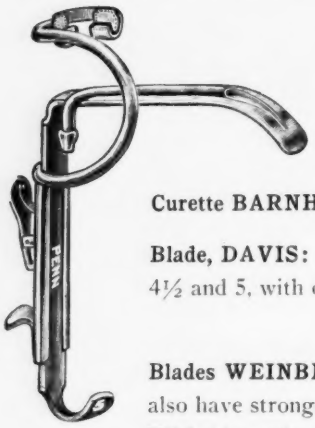

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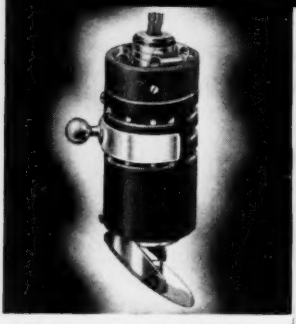

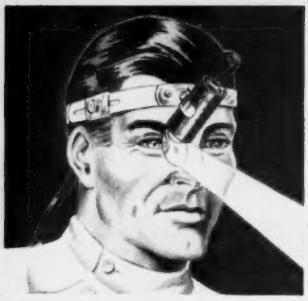

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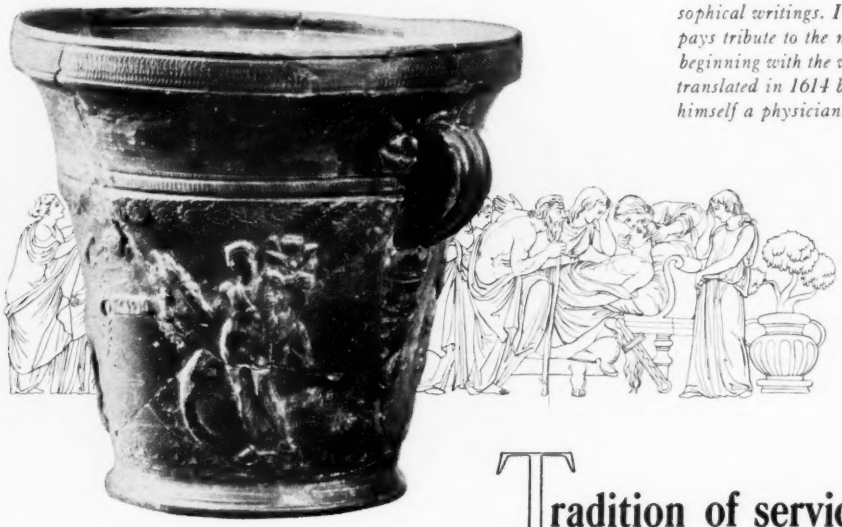

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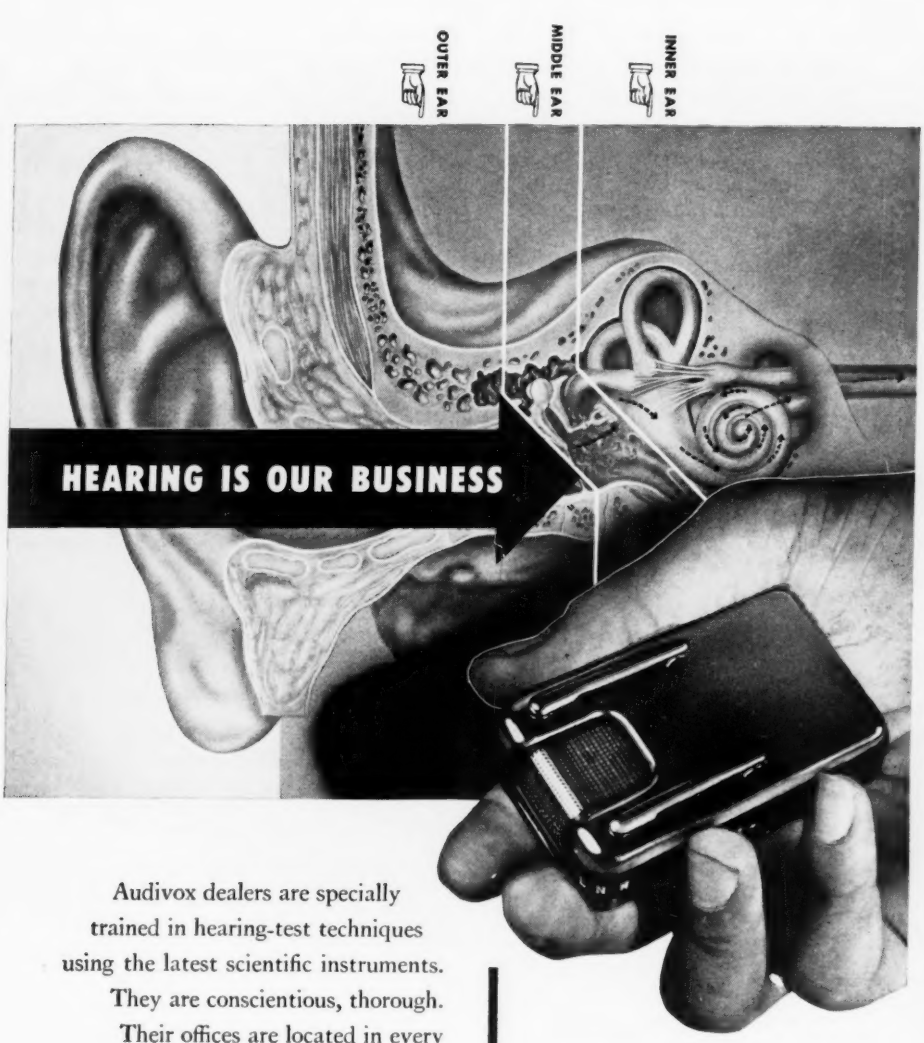

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TECHNIQUES FOR STUDY OF COCHLEAR FUNCTION AND PATHOLOGY IN EXPERIMENTAL ANIMALS

Development of the Anatomical Frequency Scale for the Cat

HAROLD F. SCHUKNECHT, M.D.
DETROIT

THE DUAL purpose of this report is to describe techniques of evaluating the function and pathology of the cochlea in animals and to present information on frequency localization in the cochlea of the cat. Credit for developing the techniques belongs to such investigators as Culler and Neff for behavioral tests of hearing, Tunturi and Hind for the cortical test of auditory function, and Stacey Guild for the method of graphic cochlear reconstruction.

The paper is divided into three sections: (*A*) tests of auditory function, including the behavioral method as used by Neff and the cortical method of Hind; (*B*) the study of cochlear pathology, encompassing a description of standard histological technique and a description of Guild's method for graphic cochlear reconstruction, and (*C*) the development of the anatomical frequency scale for the cat, based on the results of recent investigations in this laboratory.

A. TESTS OF AUDITORY FUNCTION

1. THE BEHAVIORAL METHOD.[1]—The most accurate technique yet devised for determining the auditory thresholds of animals is the behavioral method. The efficacy of this procedure was first demonstrated by Culler, Finch, Girden, and Brogden.[2] The method also is known as avoidance conditioning to distinguish it from the classic conditioning procedure first described by Pavlov. In the particular avoidance-conditioning situation used in the experiments to be described hereafter, animals were trained to walk forward in a rotating cage in response to pure-tone auditory stimuli. This response is a voluntary one and differs in no way from the motor responses (such as the movement of a digit) which human patients are requested to make during auditory testing.

Dr. Schuknecht is now at Henry Ford Hospital, Detroit, Michigan.

This work was supported by a grant from the Veterans Administration, Contract V-100 1 M-2354.

This work was done in the Division of Otolaryngology of the University of Chicago School of Medicine.

1. Behavioral testing was performed in the laboratory of physiological psychology of the University of Chicago, which is under the direction of Dr. W. D. Neff. The equipment was designed by him and is described here with his consent. Of the cats, 20 were trained and tested by me and 5 by Mr. Samuel Sutton.

2. Culler, E.; Finch, G.; Girden, E., and Brogden, W.: Measurements of Acuity by the Conditioned Response Technique, J. General Psychol. **12**:223-227 (Jan.) 1935.

Cats are suitable animals for this kind of avoidance conditioning. They learn the avoidance response after a reasonable number of trials, and they are quiet by nature and thus produce a minimum of noise, which if present would interfere with the testing procedure.

Apparatus.—Training and testing were carried out with the animal in a sound-insulated room. The experimenter sat at a control panel in an adjacent room, from which he observed the animal through a one-way window.

The rotating cage was equipped with a brake which could be adjusted to vary the effort required to move the cage. The cross bars of the cage served as electrodes through which shock was given to make the animal move forward (Fig. 1*B*). Cur-

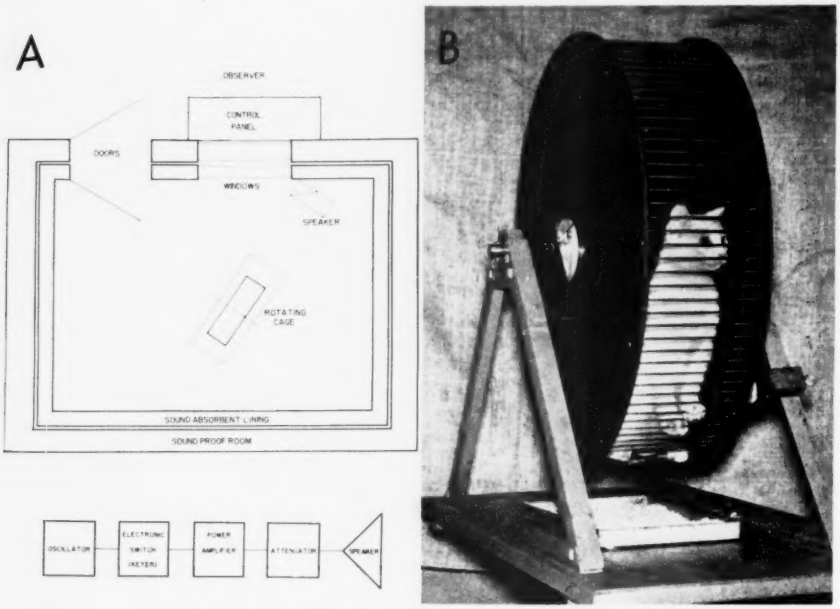

Fig. 1.—*A*, plan for soundproof room and electrical equipment used for behavioral testing; *B*, cat in rotating cage.

rent was supplied by a potentiometer with current-limiting resistance and wide intensity range.

Stimulus tones were generated by a loud-speaker actuated by the amplified current from an audio-oscillator. The intensity of the test tones was controlled in 1-db. steps by an attenuator network. By impressing the output of the variable oscillator and a 1000-cycle fixed-frequency oscillator on the plates of a cathode-ray oscillograph so as to obtain the desired Lissajous figure, the frequency was accurately controlled. The presentation of the tone, shock, and buzzer, as well as the length of each, was controlled manually or by an automatic timer consisting of a constant-speed rotating disk operating a relay system. A diagram of the testing equipment is presented in Figure 1*A*.

Procedure.—The sequence of surgical procedures and hearing tests is described hereafter.

Step *A*: As a first step an operation was performed to destroy the function of one ear of the animal. The auditory bulla was exposed through a ventral incision. With the animal under general anesthesia and with aseptic technique the bulla was opened and a probe was introduced through the round-window membrane to macerate the cochlea. The animals required about one week to recover from the vestibular upset which followed destruction of the inner ear.

Step *B*: Each animal was then trained to move forward in the rotating cage in response to pure-tone stimuli. The training procedure consisted first in delivering a fairly loud tone (usually 1000 cps) for 3 seconds, followed immediately by sufficient electrical shock to make the animal move forward. A buzzer was sounded simultaneously with the delivery of the shock and terminated the moment the animal moved forward. When the animal had learned to respond to the tone with a forward movement, the shock was omitted except for occasional reinforcement, sounding of the buzzer being continued as a supplementary reinforcing stimulus. When the animal had learned to make the correct response to the initial test frequency, he was readily trained to respond to other frequencies. For each test tone the intensity was then decreased until consistent responses were made at a level known to be near threshold for the cat.

Auditory thresholds usually were determined at each octave from 62.5 cps to 16000 cps. In some animals additional frequencies were tested. Starting well above threshold at each frequency the intensity was decreased by 5-db. steps until a level was reached at which the animal failed to respond. The intensity was then increased by 5-db. steps until the animal again made correct responses. The test tones were delivered at time intervals varying from 45 seconds to 2½ minutes so as to avoid temporal conditioning. Tests were continued until four or five threshold tests made on different days gave consistent results. The first three or four sets of threshold measurements were discarded because of the initial practice effect.

Test periods varied from 30 minutes to 1 hour. Most animals begin making correct responses after 25 or 30 trials. My associates and I discontinued training an animal that was not adapting itself to the test situation after three hours of training (one out of every four or five animals). In one experiment utilizing eight cats the average training time required to achieve the initial threshold audiograms was 13 hours for each animal. Reliable threshold audiograms have been obtained for some animals with as little as five hours' training, but this is unusual. Training periods which are too intensive may provoke an animal to make spontaneous responses, which if frequent will seriously interfere with testing. Placing the animal in the rotating cage an hour before the testing period and tightening the brake so as to increase the effort required to move forward tends to minimize spontaneous activity. An occasional animal attempts to avoid shock by rolling over on its back, which is well insulated with hair. If the animal is successful at this maneuver three or four times in the early stages of training it becomes almost impossible to train him to make the required response. This situation can be avoided by increasing the shock the moment the animal turns over.

The animal is well trained when its audiogram varies no more than plus or minus 5 db. on different test days. An animal is trained until he meets this criterion. The

audiograms obtained for animals are about as reliable as those obtained for human subjects. An occasional sophisticated cat will listen attentively for the test tone. On a hot day when his respiration is noisy he will stop breathing for a few seconds at intervals during the testing period so as to hear the test tone better.

Step *C*: A procedure was then performed to produce a cochlear lesion. All operations were done with the animal under deep general anesthesia from intraperitoneally injected pentobarbital (Nembutal). Aseptic technique was used. Penicillin was given parenterally for five to seven days in doses sufficient to maintain an adequate blood level. Saline and glucose solutions were given subcutaneously for the first 24 hours and thereafter as needed.[3]

Operations on the cochlea were performed so as to create the least possible damage to the sound-conducting mechanism. Most of the lesions were made with a very small needle introduced through a small surgical fistula in the cochlear wall or introduced directly through the round-window membrane.

Step *D*: Auditory testing was resumed about one week after operation. Tests were repeated at intervals which varied from three days to two weeks for different cats. The duration of the experiment for each cat was dependent upon a number of factors inherent in the design of the experiment. When the operative procedure involved entering the auditory bulla or middle ear, a postoperative time interval of four to six weeks was required for maximum recovery of the auditory threshold. Except for special purposes the experiments were not terminated until the auditory threshold failed to improve with time. Three audiograms then were made on successive days, after which the animal was anesthetized and killed by arterial perfusion with fixing solution.

The final audiogram is expressed in decibels of gain or loss in threshold sensitivity for the frequencies tested.

2. Cortical Method.—A cortical test of auditory function was developed by Hind [4] during the course of a basic investigation into the properties of the auditory cortex. It appears that the method may offer a considerable saving in research time as compared with behavioral testing. The method is based on the recording of evoked strychnine potentials from the auditory cortex as described by Tunturi.[5] When the auditory cortex has been treated with strychnine sulfate solution, spike-like waves of electrical potential can be recorded in response to the relatively abrupt onset of pure tones and a determination made of the sound-pressure level required for threshold at all frequencies of interest. In a chronic experiment, threshold intensities for cortical responses in an animal with an experimentally

3. Routine care of the animals consisted of supplying a varied diet of fresh meat, prepared foods, milk, canned fish, and green vegetables; keeping them in clean cages in ventilated rooms, and providing daily exercise. Cat immune globulin was given all animals entering the quarters. Sick cats were isolated and given antibiotics and fluids parenterally as needed. Delousing, worming, and mange treatment were carried out when indicated. Animals recovering from anesthesia were kept warm, the pharynx was aspirated to keep it free of secretions as indicated, and analgesics were given if they seemed necessary. The postoperative care compared favorably with that which is given human surgical patients.

4. Hind, J. E.: An Electrophysiological Determination of Tonotopic Organization in the Auditory Cortex of the Cat, J. Neurophysiol., to be published.

5. Tunturi, A. R.: Physiological Determination of the Arrangement of the Afferent Connections to the Middle Ectosylvian Auditory Area in the Dog, Am. J. Physiol. **162**:489-502 (Sept.) 1950.

produced cochlear lesion are compared with the average values obtained for a group of normal animals. A curve is then drawn for the former showing the increase in threshold sound-pressure level in decibels as a function of frequency. In acute experiments, a comparison may be drawn between the threshold values existing before and after the creation of a cochlear lesion.

The method is essentially as follows: The sound-source coupler with its microphone probe tube is sealed into the external auditory canal after removal of the pinna. The contralateral auditory cortex is exposed (Fig. 2*A*). A small patch of filter paper saturated with 3% strychnine sulfate solution is placed on the cortex. The potential difference between an electrode on the filter paper and an electrode on the neck is displayed on a cathode-ray oscilloscope. A determination is made of the minimum sound pressure required at each frequency to elicit strychnine spikes. Each stimulus tone pulse in the experiments of Hind and Hind and Schuknecht [6] had an onset- and decay-time constant of 10 msec. and a duration of 135 msec. Recordings are made from several such patches in different regions of the auditory cortex.

The method is acceptable as a test of peripheral auditory function if the test results correlate with the actual hearing ability of animals suffering from lesions of the peripheral auditory system. To test the reliability of the method, therefore, both behavioral and cortical tests were performed in a series of seven experimentally deafened animals. The cortical and behavioral tests agreed well and are reported in detail elsewhere [6] (Fig. 2*B*). The savings in research time offered by the cortical method may make it a valuable tool in the experimental analysis of the peripheral auditory system. The behavioral test remains, however, the only true test of hearing.

3. Other Methods.—The pinna reflex has been used by some investigators to determine the threshold of hearing, but the method lacks accuracy and is crude indeed in comparison with the avoidance-conditioning method. The measurement of the cochlear microphonic response has been used as an index of the functional state of the sound-conducting and sensory systems of the ear. Used for this purpose the tests have limitations. Extracochlear electrodes have the disadvantage of recording the sum of electrical potentials from a wide region of the cochlea. The microphonic activity of a restricted region can be determined only by measuring the potentials with electrodes located in the scala tympani and scala vestibuli.[7] This method has provided essential information related to the physiology of hearing but is not likely to become a routine testing procedure, because of the technical difficulty of inserting electrodes adequate to test the entire auditory spectrum.

B. STUDY OF COCHLEAR PATHOLOGY

1. Histological Technique.[8]—*Perfusion.*—The animal is subjected to deep general anesthesia, usually by intraperitoneal injection of pentobarbital. The thoracic

6. Hind, J. E., and Schuknecht, H. F.: A Cortical Test of Auditory Function in Experimentally Deafened Cats, to be published.

7. Tasaki, I.; Davis, H., and Legouix, J. P.: Space-Time Pattern of the Cochlear Microphonics (Guinea Pig), as Recorded by Differential Electrodes, J. Acoustical Soc. Am. **21**:502-510 (Sept.) 1952.

8. Mr. Robert Kimura, director of the histological laboratory of the Division of Otolaryngology, aided in the preparation of this section. The method is a standard textbook procedure with slight modifications.

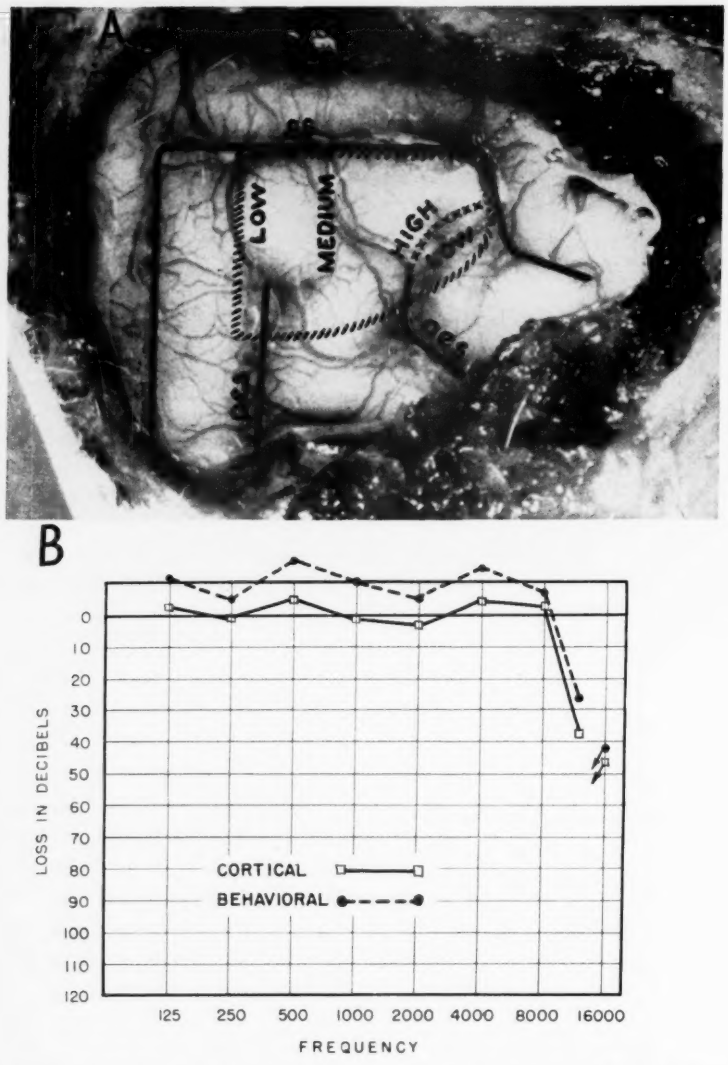

Fig. 2.—*A*, ectosylvian gyri of cat cortex showing regions of best response for low frequencies (up to 500 cps), medium frequencies (1000-4000 cps), and high frequencies (8000 cps and up); *B*, comparison of behavioral and cortical tests of auditory function for cat (Cat 1) with experimental lesion in lower part of basal coil. For each method curves are plotted as deviations in threshold sensitivity from average for normal cats.

cavity is opened. A cannula is placed through an incision in the wall of the left ventricle into the ascending aorta and tied in place. An incision is made into the right auricle to allow the escape of blood and fluids. The thoracic aorta is clamped. The animal is given a perfusion of isotonic sodium chloride solution for 10 to 15 seconds and of fixation solution for several minutes. Although several fixatives are satisfactory, Heidenhain-Susa solution has given the best results in our laboratory. The height of the perfusion bottle is 4 ft. (122 cm.) for the cat, monkey, and dog and 3 ft. (91 cm.) for the guinea pig. The animal is decapitated, and the brain is removed, the eighth cranial nerve being left in the internal auditory meatus. If desired a portion of the medulla may be left attached to the temporal bone. In the cat the petrous bone is removed with a Liston bone-cutting forceps without damaging the middle- or inner-ear structures. The auditory bulla is widely opened and the septum is removed to allow access of the fixative to the middle ear.

Fixation.—A. If Heidenhain-Susa solution is used for perfusion, the specimen is put into fresh Heidenhain-Susa solution for 24 hours.

B. If 10% formalin is used for perfusion, the specimen is placed in 10% formalin for further fixation. It is placed in fresh solutions of formalin on both the second and the third day. Solutions of formalin are prepared with freshly degassed distilled water. After five days the specimen is transferred to decalcifying solution.

Decalcification.—Decalcification is accomplished with 5% trichloroacetic acid for Heidenhain-Susa-fixed bones. The specimen is put into a fresh solution every three days. Nitric acid for formalin-fixed specimens is used according to following formula:

Concentrated nitric acid.....	1 part
Commercial formalin.....	5 parts
Distilled water (degassed).....	45 parts

The specimen is suspended in the solution on a string. Several methods can be used to determine the end-point of decalcification:

A. A method sometimes used is to probe the specimen with a needle. The method is not reliable, as undecalcified areas may remain undetected and artefacts may be produced by the needle.

B. A common procedure involves the use of chemical tests for calcium in the solution. It seems unnecessary, however, to continue decalcification to the point where no more calcium appears in the solution.

C. As undecalcified bone is relatively radiopaque, roentgenograms of the specimen can be used to reveal the end-point of decalcification. This technique is the preferred one in our laboratory.

The average length of time for decalcification has been 1 day for the rat and bat, 2 to 3 days for guinea pig, 6 to 10 days for the cat and dog, 10 to 14 days for the monkey, and 25 to 30 days for the human.

Washing and Neutralization.—The specimen is washed overnight in running tap water. It is then placed in a solution of 5% sodium sulfate for 24 hours and in distilled water for 3 to 6 hours.

Dehydration.—The specimen is passed through 400-cc. quantities of ethyl alcohol solution in the following concentrations: 35%, 50%, 60%, 70%, 80%,

95% (once used), 95% (fresh), absolute (once used), absolute (fresh), and, finally absolute alcohol and ether in equal parts, two changes. The process is carried through solutions of increasing concentrations to the 80% alcohol over a period of two days. The specimen is placed in each of the remaining higher concentrations for 24 hours. All alcohol solutions up to 95% are degassed. Iodine is added to the 70% and 80% alcohols to remove the mercury if Heidenhain-Susa fixative was used. Slightly longer dehydration periods are needed for human temporal bones.

Embedding.—Cat temporal bones are embedded in collodion in increasing concentrations as follows: 1.5% (in equal parts absolute alcohol and ether) for 2 to 3 days; 3% for 10 to 14 days; 6% for 10 to 14 days, and 12% for 10 to 14 days. For larger specimens, such as human temporal bones, the embedding time must be increased.

The specimen remains in 12% collodion in a loosely covered glass container until the surface of the collodion becomes tacky (two to three weeks). A layer of about ¼ in. (0.64 cm.) of chloroform is placed on the surface of the collodion, the container is tightly covered, and the collodion is allowed to harden (two to three days).

The collodion mass containing the specimen is removed and trimmed into a quadrilateral block so orientated that the modiolar axis of the cochlea lies in the horizontal plane. It is then placed in 80% alcohol for at least two days before sectioning.

Sectioning.—For routine study, sectioning is done in the horizontal plane beginning on the upper surface (floor of middle cranial fossa). Ordinarily bones of the cat, monkey, and human are cut at 20-μ, those of the guinea pig at 14-μ, and those of the bat and rat at 10-μ thickness. Every 5th section of animal bones and every 10th section of human bones is handled separately for the staining of a "tracer" set of slides.

Staining.—The hematoxylin and eosin stain is used for routine study. The sections are placed in distilled water and then in Harris hematoxylin for 15 minutes. They are transferred to distilled water for 15 minutes, destained in 1% acid alcohol, rinsed in plain tap water, neutralized in a slightly basic tap water until the blue color returns (15 to 30 seconds), and then placed in distilled water for at least 2 minutes.

The section is placed in Eosin Y (1 gm. eosin Y, 25 ml. of 95% alcohol, and 75 ml. of distilled water) for 15 to 60 sec. A few drops of glacial acetic acid may be required to increase the intensity of the stain. The section is destained by rinsing in two changes of 80% alcohol, in two changes of 95% alcohol, and very briefly in absolute alcohol and is then cleared in equal parts of terpineol and xylene for at least 10 minutes.

Sections are mounted with H. S. R. mounting medium[9] (Hortmann Leddon Co.). Lead weights are placed on the cover slips, and the slides are allowed to dry at room temperature away from direct light.

Other stains satisfactory for temporal-bone sections are Mallory's azan, Masson's trichrome, Bodian's, phosphotungstic acid hematoxylin, and iron hematoxylin.

9. Interim Report of the Committee on Mounting Media: Resinous Media, Stain Technol. **25**:1-9 (Jan.) 1950.

The sections are orientated on the slide so that the axis of the modiolus is perpendicular to the long axis of the slide with the apex downward, thus facilitating microscopic study of the serial sections.

2. Graphic Reconstruction of the Organ of Corti.—Guild introduced a significant improvement in the method for studying pathology of the inner ear when, in 1921,[10] he described the technique for graphic reconstruction of the organ of Corti. The method provides a means for spatially orientating structures within the cochlea and is essential to the fullest interpretation of pathological changes.

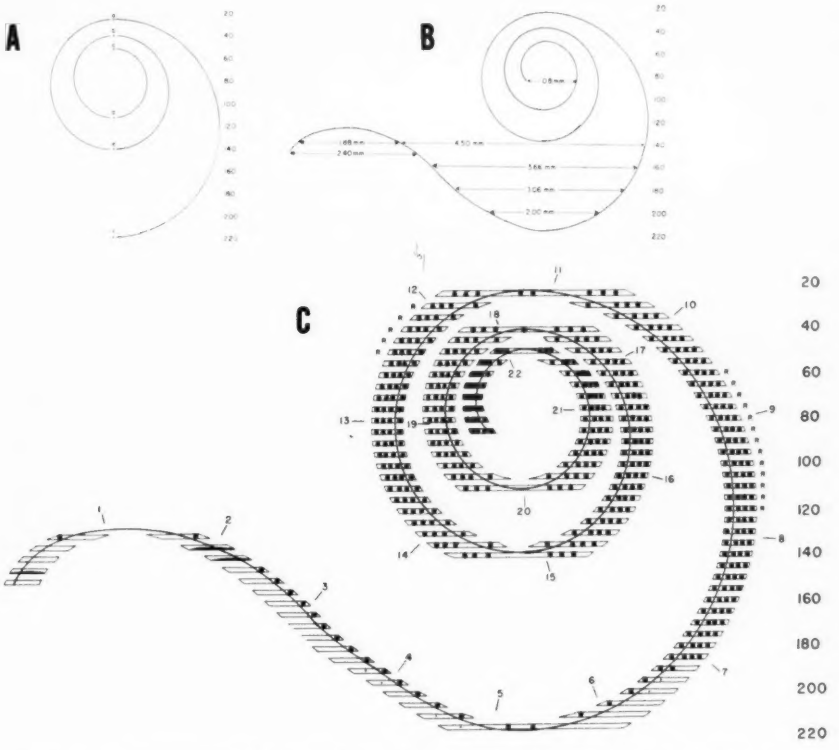

Fig. 3.—Progressive steps in graphic reconstruction of cochlea. Detailed description is given in text.

In the following paragraphs the method for reconstruction of the organ of Corti is presented essentially as Guild described it. The method is simple, and its use is imperative for careful study of the sense organ.

The method as it is to be described applies to routine histological preparations of the cochlea consisting of horizontal sections cut at 20 μ with every fifth section mounted and stained for study. The sections are numbered consecutively beginning at the superior aspect of the cochlea.

10. Guild, S. R.: A Graphic Reconstruction Method for the Study of the Organ of Corti, Anat. Rec. **22**:141-157 (Sept.) 1921.

A. Slides containing the organ of Corti are listed vertically on the horizontal lines in consecutive order along the right-hand edge of a large sheet of graph paper (Fig. 3).

B. The sections are selected which tangentially cut the line of contact of the heads of the inner and outer pillar cells. A typical section is seen in Figure 4 *A*.

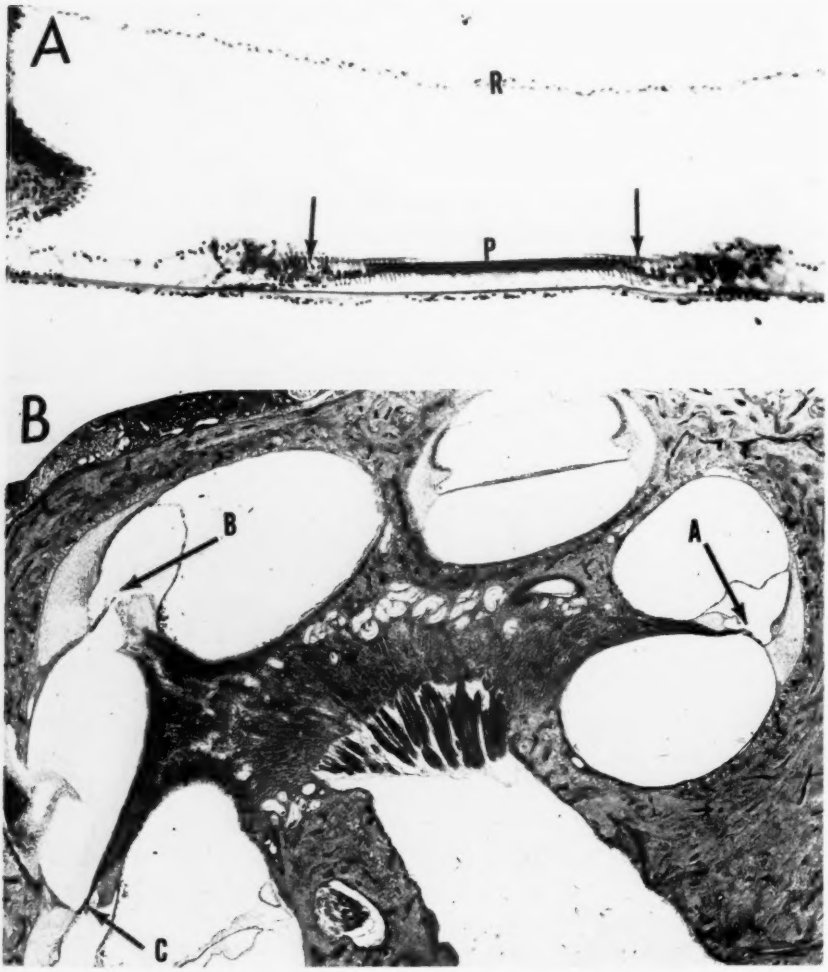

Fig. 4.—*A*, section cut tangentially to line of contact of heads of pillars. *R* is Reissner's membrane. *P* indicates heads of pillars. On each side is that part of organ of Corti which lies external to pillars and contains outer hair cells (arrow). *B*, section 140 of graphic reconstruction appearing in Figure 3. Organ of Corti has been sectioned through lower basal coil and hook. Distance between organ of Corti from *A* to *B* is 4.50 mm. and from *B* to *C* is 1.88 mm. Figure 3 *B*.

These points are located on the graph on a common vertical line such as the points *a*, *b*, *c*, *d*, *e*, and *f* of Figure 3*A*. When the tangent intersecting the line of contact

of the heads of the inner and outer pillar cells lies between two sections the point is placed between the horizontal lines on the paper. The number of points to be plotted will be six for the cat cochlea (three turns).

C. These points are then connected by semicircles having their centers on the common vertical line. Each semicircle represents a half turn of the cochlea.

D. The contour and the location of the end of this line at both its apical and its basal end must be determined by actual measurement. The section is selected which contains the most apicalward union of the heads of the pillar cells. The distance is measured between this union and the union of pillar cells of the half turn continuous with it. This point is located on the graph by multiplying the measured distance by the scale of the graph. An arc is drawn from this point to the half turn continuous with it. A number of sections traverse the inferior arc of the basal turn. From several of these sections measurements are made of the distance from the union of pillar cells on one side to the union on the other. Each measured distance is projected on the horizontal line representing the section. A line is drawn between the projected points as a continuation of the basal turn, as seen in Figure 3*B*. In the cat as in a number of other animals, the basal coil alters its course to form a "hook" having a dorsal relationship to the round window. To project the hook, two sections must be identified: first, the section containing the extreme basal end of the union of the heads of the pillar cells and, second, the section which contains the tangential cut through the union of the heads of the pillars along the dorsal arc of the hook. Measurements are then taken in the usual manner from several intervening sections, and the line of the hook is drawn as a continuation of the basal coil. A photomicrograph of Slide 140 appears in Figure 4*B*.

E. In recording the pathology of the organs of Corti we have followed the method of Guild, in which the organs of Corti are represented as quadrilateral boxes drawn at the junctions of the spiral line with the horizontal lines. Each normal hair cell is recorded as a large dot in its relative location within the quadrilateral box. An abnormal-appearing hair cell is represented as a small dot. It should be emphasized that to record a hair cell as present does not necessarily imply that the cell is capable of normal function. Abnormal forms are numerous in the acute phase of a pathological process. In chronic experiments abnormal hair cells commonly appear at the periphery of a lesion.

Thus when the quadrilateral boxes have been made and the dots have been placed in their proper location the reconstruction will appear as shown in Figure 3*C*.

F. Finally, the length of the organ of Corti is determined by measuring along the line which represents the union of the heads of the pillars. The measurement should begin at the basal end with calipers adjusted to a scale of 0.25 mm.

The average length of the organ of Corti as measured by this method in 26 cat cochleas was 22 mm., the length ranging from 20 to 23.1 mm. Several factors may account for the differences in measured length: (1) actual anatomical variations in cochlear size; (2) artefacts due to histological preparation of the ear, such as that which might occur from shrinkage, and (3) error which is inherent in the method of reconstruction.

Guild estimated the error in graphic reconstructions of guinea-pig ears. He made a comparison of the length on the microscopic slides of the chords subtending the

arcs of the line of union of the heads of the pillar cells with the chords of the arcs on the reconstruction. On the average the error was less than 5%.

Some error arises from the fact that the method of reconstruction fails to take into account the height of the cochlea. To study this error, a geometric side-view projection has been made for the upper two and one-half turns of the cochlea of a cat (Fig. 5). The measured length of this projection is 13.81 mm. In the simple top-view reconstruction it is 13.43 mm., an error of 2.8%.[11]

A small error probably also arises from the use of a series of semicircles, since the cochlea more nearly follows the course of a spiral of constantly changing radius.

The error incurred in reconstruction of the lower part of the basal turn and the "hook" is probably not great, because the projection is based on actual measurements of the length of the chords of arcs formed by the union of the heads of the pillar cells.

The simple top-view reconstruction appears to be sufficiently accurate to obviate the necessity of extensive computations for error.

3. Reconstruction of the Spiral Ganglion.—The top-view reconstruction of the spiral ganglion may be made on a large piece of tracing paper laid on the graphic reconstruction of the organ of Corti for the same ear. This procedure obviates the necessity for again recording slide numbers, and it places the reconstructions in a relationship which facilitates correlative studies. The method of development is similar to that already described for study of the organ of Corti. The projected line in this case represents a line passing through the center of the spiral ganglion. First, the sections are identified which tangentially cut the arcs of a hypothetical line passing through the center of the spiral ganglion. These points are located on a vertical line with reference to the underlying graph of the organ of Corti. The contour and length of this line at both its apical and its basal end are determined by actual measurement, as described previously for the organ of Corti.

The reconstructions having been superimposed upon each other, the problem remains of locating on them functionally related sensory and neural elements.

It is known that the nerve fibers from the spiral-ganglion cells pass directly radially to the organ of Corti. After reaching the organ of Corti many of the nerve fibers to the outer hair cells take a spiral course, some toward the base and some toward the apex. The length of these spiral fibers and the number of hair cells innervated by each fiber is not known.[12] It seems safe to assume that the hair cells in general receive their dominant afferent innervation from the neural elements which lie radial to them. This assumption receives support from a number of studies which show that injury to the organ of Corti is followed by degeneration of radially located spiral-ganglion cells. In the reconstruction of the organ of Corti orientation was achieved by measuring the distance in millimeters. For the spiral ganglion we have attempted to locate as rationally as possible the points having a radial relationship to the organ of Corti.

In Figure 6, *A* and *B*, appear the spiral developments for both the spiral ganglion and the organ of Corti for a cat ear. The relationship of corresponding points as

11. Mr. Richard Woellner assisted with the geometric projections.

12. Fernandez, C.: The Innervation of the Cochlea (Guinea Pig), Laryngoscope **61**:1152-1172 (Dec.) 1951.

they appear in the top-view reconstructions is shown in linear form in Figure 6*C*. A unit length of spiral ganglion appears to serve a greater length of the organ of Corti at both ends, particularly the apical end. This is due partly to failure of the two-dimensional top-view reconstructions to consider the height of the cochlear "cone," thus creating a greater relative shortening of the spiral ganglion than of the organ of Corti.

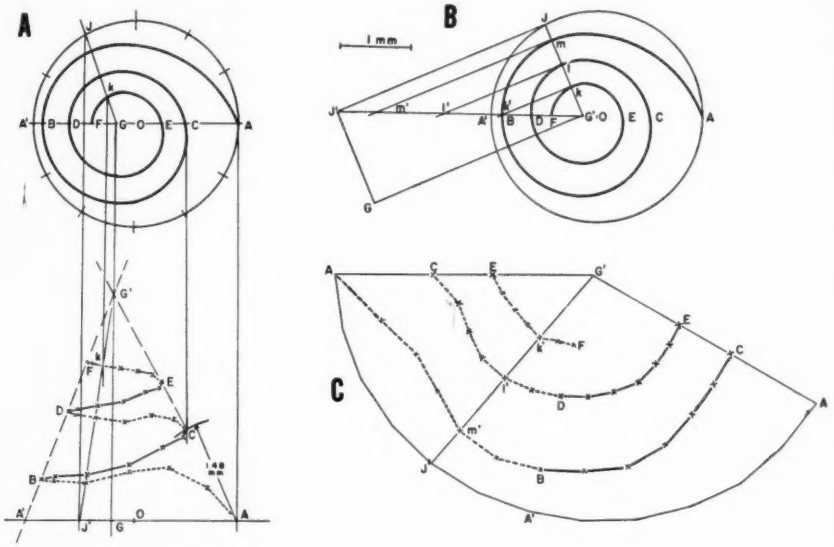

Fig. 5.—Development of side-view projection from top-view reconstruction of organ of Corti in upper two and one-half turns of cat cochlea.

A, at upper left, heavy line is top-view graphic reconstruction of organ of Corti in upper two and one-half turns of cat cochlea. Beneath is side-view projection developed as follows: Point *A* on side-view projection is placed vertically below *A* of top-view spiral. Distance between *A* and *C* is measured on mid-modiolar section (1.48 mm. in this cochlea), and arc is described at *C*, as shown. Point *C* on side-view projection is located where this arc is intercepted by perpendicular line extending down from *C* of top-view reconstruction. Points *B*, *D*, *E*, and *F* of side-view projection are located in similar manner. Sides of cone are completed by lines extending through *BDF* and *ACE*. Base of cone *AA'* of side-view projection is drawn as horizontal line and is projected to top-view reconstruction as circle *AJA'*. This circle is divided into 12 equal arcs. Apex of cochlear cone *G'* of side view is projected up to form point *G* on top-view reconstruction. Radiating lines are drawn from *G* to 12 points on circle (for example, *GJ*). A perpendicular line extending down from *J* of top-view reconstruction will locate corresponding point *J'* on base *AA'* of the side-view projection. *J'G'* is then drawn on side-view projection. Radial line *GJ* of top-view reconstruction intersects cochlear spiral at several points, for example *K*. A vertical line from *K* intersects *G'J'* of side-view projection to locate corresponding point *K* on this view. By repeating latter procedure for all points at which radial lines intersect spiral on top view, path of organ of Corti is traced on side-view projection, as shown.

B, all radial lines on side-view (e. g., *J'G'*) are foreshortened except sides *AG'* and *A'G'*. Their true lengths can be established by method of right triangles. Thus also actual distance between coils can be determined (e. g., distances between *K'*, *L'*, and *m'*).

C, radial lines of cone as measured by method described are projected from central point *G'*, separated at their distal ends by length of chords of arcs marked on circle in top-view of Figure *A*. This procedure results in spread-out polygon representing unrolled cone. Points representing organ of Corti are placed along these radial lines at distance determined by method shown in Figure *B*. Connecting these points gives curve of spiral spread out along unfolded cone. Thus, measured length for upper two and one-half turns of cochlea is 13.81 mm., whereas in top-view reconstruction it is 13.41 mm.

In Figure 7 appear the side-view projections of the organ of Corti and spiral ganglion in the upper 13 mm. of a cat cochlea. The spirals have been placed in their proper anatomical relationship, and a series of radial lines have been drawn between them to indicate the probable location of anatomically related points in these structures.

In most studies the spiral ganglion has been evaluated in terms of the estimated percentage of cell bodies (or nerve fibers) remaining after degeneration has occurred. It requires two to four weeks for degeneration to become complete after injury to the cell, so that examination for neural degeneration is not meaningful in acute experiments.

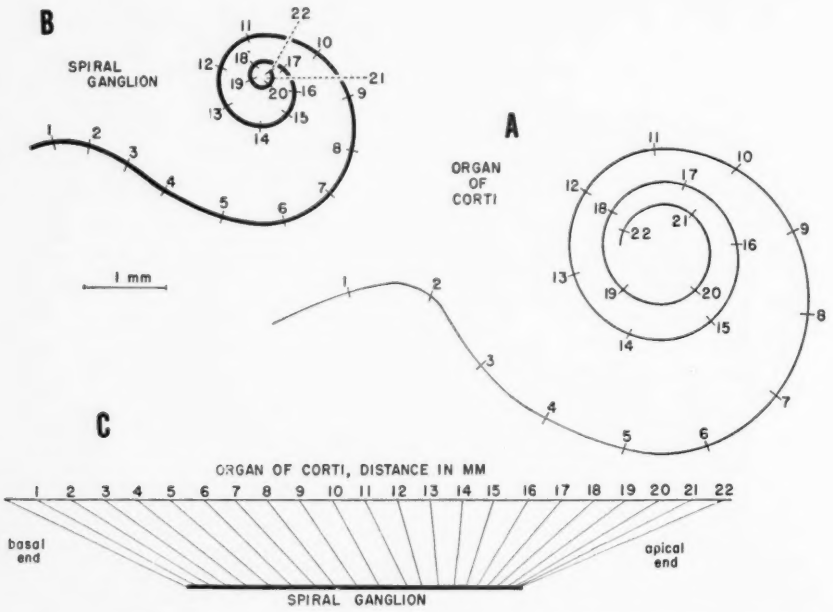
B
SPIRAL GANGLION
A
ORGAN OF CORTI
1 mm
C
ORGAN OF CORTI, DISTANCE IN MM
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
basal end
apical end
SPIRAL GANGLION

Fig. 6.—*A*, spiral representing line of union of heads of pillar cells in cat ear. Distance is indicated in millimeters. *B*, from same ear, spiral representing line passing through center of spiral ganglion. Numbers indicate points having a radial relationship to millimeter points along organ of Corti. *C*, *A* and *B* unfolded into linear graph to show relationship of corresponding points. Unit length of spiral ganglion appears to serve greater length of organ of Corti at both ends, particularly at apical end.

Another method of evaluating the first order neuron is to estimate the number of peripheral nerve fibers remaining in the osseous spiral lamina. This judgment is based mainly on the density of the stain taken up by the nerve tract. Even with special nerve stains the fibers are usually too concentrated to be counted.

A more accurate quantitative method for determining degenerative change in the spiral ganglion is based on actual counts of the population density of neuron cell bodies in the spiral-ganglion canal. This method is most reliable for animals having

a concentrated spiral ganglion (cat, guinea pig, dog) and is less so for ears having a clustered ganglion (human). The method is described in detail elsewhere.[13]

C. THE ANATOMICAL FREQUENCY SCALE

From a total of 26 experimentally deafened ears on which audiometric and histological studies are available, 16 had relatively abrupt hearing losses. For most of these ears there were differences in threshold sensitivity greater than 30 db. over a frequency range of one octave. In every ear the hearing losses were related to cochlear lesions of limited size. The margins of the lesions were characterized by an abrupt transition from abnormal to normal of the sensory (and/or neural) elements.

An examination of the audiogram and graphic reconstruction for Cat 1 in Figure 8 shows that the audiogram is plotted in the conventional manner, with frequency represented along the abscissa on a logarithmic scale. Hearing loss is

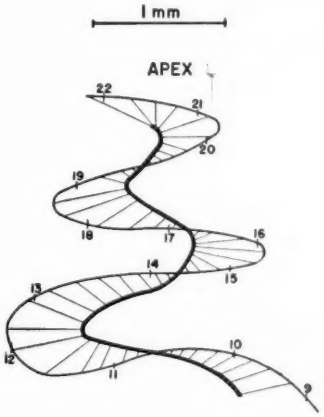

Fig. 7.—Side-view projection of organ of Corti and spiral ganglion in upper 13 mm. of cat cochlea. Numbers indicate distance in millimeters along organ of Corti. Radial lines indicate probable anatomical relationship of sensory and neural units.

recorded on the ordinate as loss in decibels from the animal's preoperative threshold. Hearing by behavioral test is essentially normal up to and including 8000 cps. The animal did not respond, however, to 16000 cps delivered at an intensity of 65 db. above its preoperative threshold.

Histological examination of the cochlea revealed a loss of the outer hair cells and some of the inner hair cells to the 6.8-mm. point, beyond which the organ of Corti was normal. A partial loss of spiral-ganglion cells was limited to the region between 1.5 and 2.6 mm. Thus it is reasonable to assume that the hearing loss was due to a sensory lesion, the margin of which lay at 6.8 mm., and that the area of maximum excitation for 16000 cps was within the limits of the lesion basal to 6.8 mm. and the area of maximum excitation for 8000 cps was apical to 6.8 mm., where

13. Schuknecht, H. F., and Woellner, R.: Hearing Losses Following Partial Section of the Cochlear Nerve, Laryngoscope **63**:441-465 (June) 1953.

the organ of Corti was normal. Thus a point 6.8 mm. from the basal end of this cochlea was located somewhere between the areas of maximum excitability for 8000 cps and 16000 cps. It should be understood that this point was not necessarily located midway between the areas of excitation for these frequencies but could have been nearer one or the other.

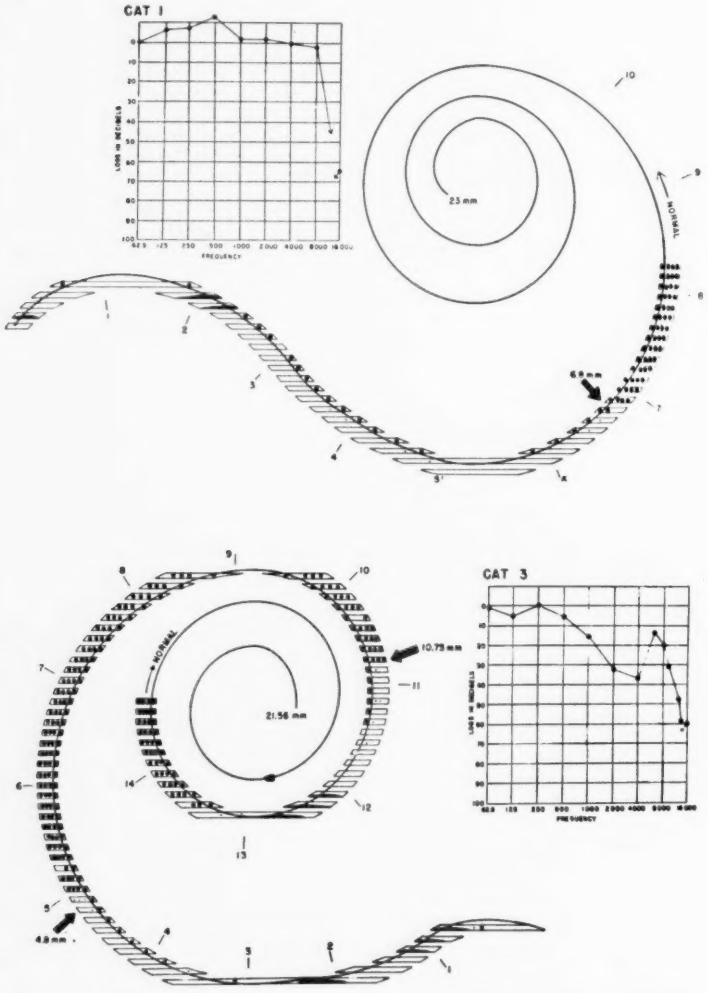

Fig. 8.—Abrupt high-tone hearing loss in behavioral audiogram between 8000 and 16000 cps for Cat 1 is result of experimental needle injury to basal coil. There is loss of outer hair cells to 6.8 mm. region, whereas remainder of cochlea appears normal. For Cat 3, a needle lesion involving isolated regions of basal and middle coils has created two dips in behavioral audiogram. Margins of lesions located at 4.8 mm. and 10.75 mm. are related to abrupt differences in threshold sensitivity of 8000-16000 cps and 4000 to 8000 cps.

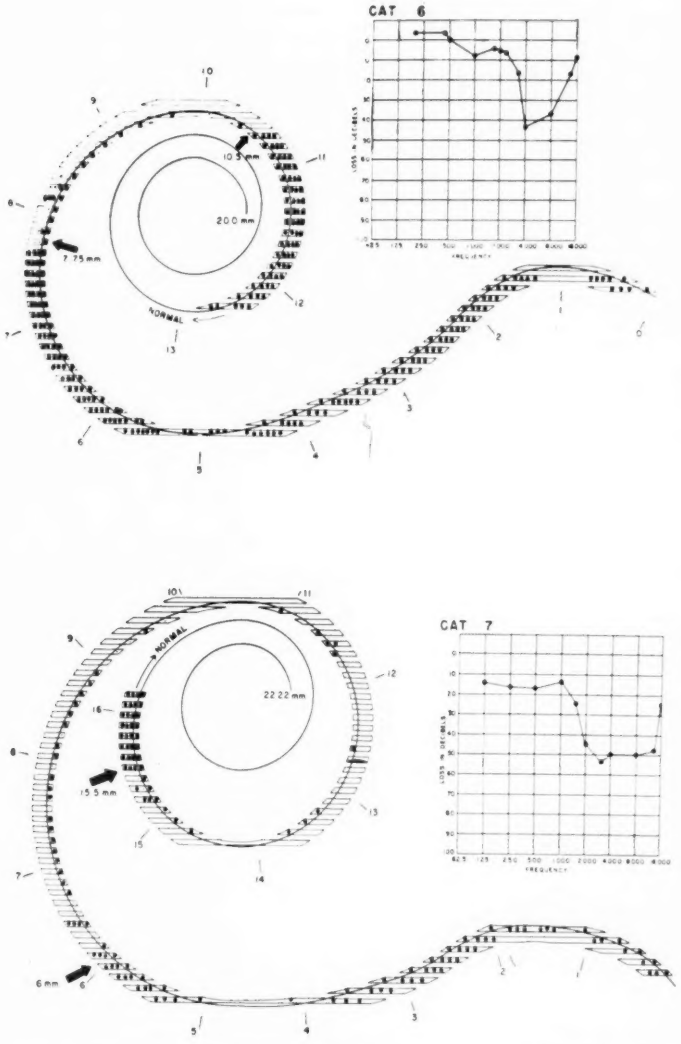

Fig. 9.—Cat 6, experimental stimulation deafness; behavioral audiogram. The 7.75 mm. point presumably lies between areas of maximum excitability for 8000 cps and 16000 cps in this ear. Likewise, 10.5 mm. lies between regions of most importance for 2000 and 4000 cps. Cat 7, experimental stimulation deafness; behavioral audiogram. Same reasoning may be applied to findings in this ear.

This type of analysis was performed for 20 regions in 16 ears. A lesion involving only the spiral ganglion was the cause of the hearing loss in 3 ears, whereas a lesion involving primarily the organ of Corti was present in 13 ears. The threshold was better for the higher frequency in 9 of the ears and better for the lower frequency in 11.

It was possible to make one correlation for the frequency range 250 to 500 cps, two for 500 to 1000 cps, two for 1000 to 2000 cps, two for 2000 to 4000 cps, seven

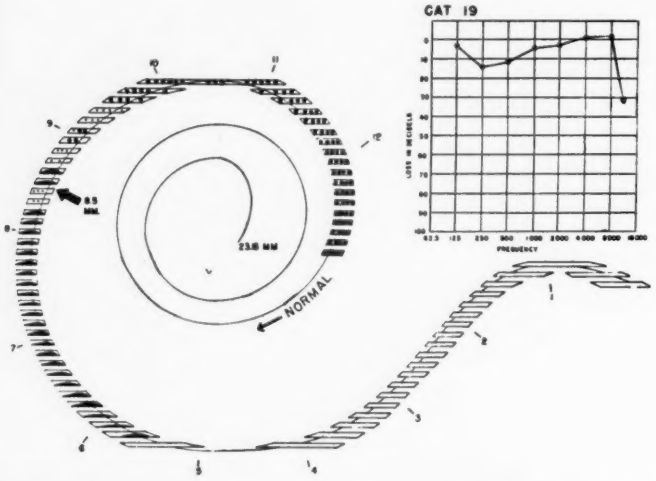

Fig. 10.—Cat 19, abrupt high-tone deafness for frequencies above 8000 cps, on behavioral testing found to exist prior to experimentation on ear, is associated with basal lesion having its margin at 8.5 mm.

Location of Margin of Lesion

Frequency	Cat	Total Length of Cochlea	Location of Margin of Lesion		
			Mm.	% of Length	Mean, %
250-500	8 *	21.6	18.3	84	84
500-1000	12 †	22.5	16.7	74	78
	9 *	23.8	20.0	83	
1000-2000	22 †	21.3	13.7	64	67
	7 †	22.2	15.5	70	
2000-4000	6 †	20.0	10.5	52	48
	11 *	21.3	9.5	44	
4000-8000	4 †	21.7	9.5	44	44
	17 * ‡	21.3	11.5	54	
	3 *	21.5	10.7	50	
	2 †	21.2	5.7	37	
	5 †	21.9	10.3	47	
	18 * ‡	21.4	9.5	44	
	16 † ‡	22.8	7.0	30	
8000-16000	1 †	23.0	6.8	30	31
	3 †	21.5	4.8	22	
	6 *	20.0	7.7	39	
	7 *	22.2	6.0	27	
	19	23.1	8.5	37	
16000-32000	16 * ‡	22.8	3.7	16	16

* Higher frequency has better threshold.
† Lower frequency has better threshold.
‡ Lesion restricted to spiral ganglion.

for 4000 to 8000 cps, five for 8000 to 16000 cps, and one for 16000 to 32000 cps. The data are shown in detail in the accompanying table. For each observation the location of the margin of the lesion has been converted to percentage of the distance along the cochlea. The mean of the measurements for the ears in each frequency range appears in the last column.

In Figures 8, 9, and 10 appear the audiograms and spiral graphic reconstructions for the ears of Cats 1, 3, 6, 7, and 19 used for study of the 8000-16000 cps frequency range. The periphery of the lesion was located at 30%, 22%, 39%, 27%, and 37% of the length of the cochlea, respectively, the mean being 31%. In three of these ears the threshold was better for 8000 cps, and in two it was better for 16000 cps.

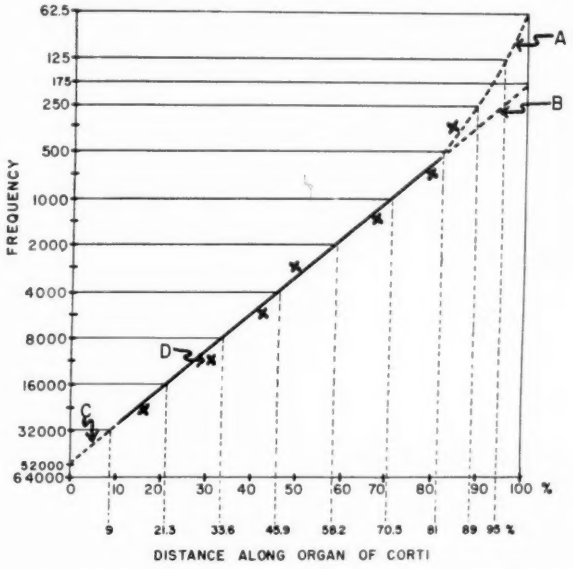

Fig. 11.—Distance along cochlear duct in percentage is plotted as function of frequency. Frequencies are represented along ordinate on logarithmic scale. Mean percentage distances for various frequency ranges (table) have been placed in proper locations. Thus point *D*, representing 8000-16000 cps range, is located on line extending from point midway between 8000 and 16000 cps and 31% of way along the cochlea. Details are given in text.

Presumably if a great number of correlations could be made the mean distance would represent a point on the cochlear duct lying midway between the points of maximum excitation for 8000 cps and 16000 cps.

In Figure 11 distance along the cochlear duct is plotted as a function of frequency. Frequency is represented along the ordinate on a logarithmic scale. The mean percentage distances for the various frequency ranges as determined by the method just described have been placed in their proper locations. Thus point *D*, representing the 8000 to 16000 cps range, is located on a line extending horizontally from a point midway between 8000 and 16000 cps and 31% of the way along the cochlea as measured from the basal end.

A line drawn through these points indicates that the logarithmic frequency scale has a nearly linear relationship to distance in the range 500 to 32000 cps. If one assumes that this linear relationship holds for both ends of the cochlea, represented by the broken lines *B* and *C*, then the highest and lowest frequency still having a point of maximum excitation would be 52000 and 175 cps, respectively. The upper limit is very close to the highest frequency for which cortical potentials can be recorded in the normal cat ear. The data indicate that the frequencies below 500 cps are located in the apical 19% of the cochlea, but from neither these experiments nor others is there information regarding the distribution of these frequencies over this area.

Bekesy's [14] investigations indicate that the lowest frequency still having a point of maximum displacement in the human cochlea is about 25 to 35 cps. Thus, because

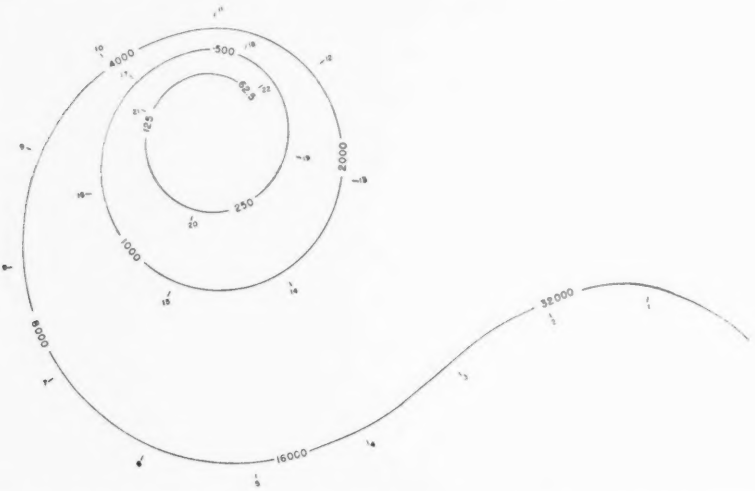

Fig. 12.—Cat's organ of Corti of average length (22 mm.) on which are indicated regions of maximum excitability for various frequencies of its auditory spectrum.

cats appear to have a poorer sensitivity for low frequencies than humans, it seems reasonable to believe that the lowest frequency having a point of maximum displacement is greater than 35 cps. If this frequency were 62.5, then the contour line *A* would indicate the extent of departure from linearity for the frequency/distance function. This fact does not mean that the cat is incapable of hearing frequencies lower than 62.5 cps, as lower frequencies would be expected to excite the apical end of the cochlea with the so-called tail-end of the wave. The low frequency 62.5 is a purely arbitrary end-point subject to correction when more information becomes available. An error in selecting this point probably is not serious from a practical standpoint, because of (1) crowding of frequencies at the apex and (2) spreading of the fields of excitation for low frequencies with increasing stimulus intensity.

14. Bekesy, G. V., and Rosenblith, W. A.: The Mechanical Properties of the Ear, in Handbook of Experimental Psychology, edited by S. S. Stevens, New York, John Wiley & Sons, Inc., 1951, pp. 1075-1115.

Lines are drawn from the frequency scale to intersect the contour line, and from these points a broken line is dropped downward onto the distance scale. The lower figures on the abscissa therefore indicate the approximate areas of maximum excitation for these frequencies in percentage terms.

When the frequencies are arranged on the abscissa of the audiogram in accordance with these findings (32000 cps at 9% of the distance, 16000 cps at 21.3%, 8000 cps at 33.6%, and so on) the scale is termed the anatomical frequency scale. A similar scale was employed previously by Koenig [15] for psychoacoustic data and by Davis and associates [16] in a study on aural microphonics in the guinea pig. The scale used by them was logarithmic above 1000 cps and arithmetic below 1000. Each 100-cycle interval below 900 was equal to the distance on the logarithmic scale from 1000 to 900.

The anatomical frequency scale as developed for the cat has a direct application in the presentation of research data because it is possible to relate graphically on common or parallel coordinates the functional and pathological changes of the cochlea.

It should be understood that the orderly arrangement of frequency response along the cochlear duct, as shown in Figure 12, does not necessarily strengthen the "place" theory of pitch perception. It appears that the fields of excitation are not so sharply localized that pitch perception can be accounted for on this basis alone.

It might be well to borrow the terminology of Ruch,[17] who referred to cortical excitation in terms of "modal excitation fields" (modal implying only that they are peaked). Thus the cochlear response to a pure-tone stimulus does not occur at a point of excitation but in a "modal excitation field."

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15. Koenig, W.: A New Frequency Scale for Acoustic Measurements, Bell Laboratories Record, Aug., 1949, p. 269.

16. Davis, H.; Gernandt, B. E.; Riesco-MacClure, J. S., and Covell, W. P.: Aural Microphonics in the Cochlea of the Guinea Pig, J. Acoustical Soc. Am. **21**:502-510 (Sept.) 1949.

17. Ruch, T. C.: Cerebral Cortex: The Parietal Lobes and Somatic Sensation, in J. F. Fulton, Editor: Physiology of the Nervous System, Ed. 2, New York, Oxford University Press, 1943, Chap. 19.

ULTRASONICS AND OTOSCLEROSIS

A New Concept of Its Origin

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NEW YORK

OTOSCLEROSIS, its causes and cure, has consumed the energies of many scientific investigators in various disciplines of medicine without success. The embryologist, the histologist, the pathologist, the clinician, the surgeon, have all, individually and collectively, exerted themselves in seeking to find a cure for this heretofore unexplained malady. Otosclerosis, causing chronic progressive hearing loss, affects the destiny and serviceability of many millions of persons everywhere. New concepts, new hypotheses, new explanations for otosclerosis, accepted originally with enthusiasm, have one by one volatilized and left otologists with the stark reality of this unexplained disease. The historical aspects of the study of the condition have been reiterated so often that it would serve no purpose to do so again. The constant search for a medical or surgical cure has reached a culmen through the tireless, ceaseless efforts and contributions of many scientists. Their limitless ingenuity and investigative brilliance have been the greatest factors in the establishment of a surgical technique which holds in its potential eventual hope for those who are deaf as a result of otosclerosis. Their researches, however, have failed to explain the hereditary aspects of otosclerosis, the otosclerotic sites of predilection, and the bony changes this unique condition. In newer studies of the basic, physiological mechanism of otosclerosis will the key be found to unlock the mystery that has so successfully enshrouded this condition. The eventual eradication of otosclerosis may lie in a discipline thus far unrecognized, or perhaps disregarded.

Among the common fallacies of many scientific investigations are the perpetuation and the reiteration of previously stated ideas, any deviation from which rarely occurs unless there is a complete upheaval by a newer scientific approach. We are living in an era of great scientific upheavals. One of the newer factors which is stimulating investigations previously thought to be unapproachable is the science of ultrasonic vibrations. Observations of the effects of sonic and ultrasonic vibrations on man have opened new areas of untapped resources. These effects, when coordinated and translated, may eventually be significant factors in the solution of problems heretofore a source of scientific frustration.

SOUND TRANSMISSION

A discussion of the possible relationship between otosclerosis and ultrasonic vibrations is presented in the hope that herein may lie a clue to the basic phenomena which produce these characteristic changes in the temporal bone. The following acoustical axioms are included only for the purpose of introduction and emphasis.

Propagation of sound in man is produced essentially through the medium of solid bodies or of air. The articular chain and the air surrounding the ossicles and the tympanum well illustrate such transmission. When sound waves pass from an air medium to a solid medium, the waves are perceptibly altered. If a transparent membrane is interposed between the air and the watery medium, the sound waves are propagated with greater intensity. Sound waves are a form of energy and are produced by air vibrations. Sound waves are characterized by alternating condensation and rarefaction of pressure. Sound waves are conducted from air through the solid bodies of the articular chain to the labyrinthine fluid. It is well established that a solid body isolated and surrounded by air is an excellent conductor of sound waves. The articular chain prevents the dispersion of sounds and sound vibration so that there is no loss of intensity in sound transmission to the labyrinth and labyrinthine fluid.

The transmission of sound waves is not unlike the transmission of light waves, which are sensed as variations and nuances in color according to the frequency of the light wave vibrations. The otologist is aware of acoustical phenomena in various pitch frequencies and intensities and their significance in terms of critical areas of speech and hearing. He is aware, too, of the exceedingly high frequencies, which, though imperceptible to the human ear, can affect the function of man. Again, the analogy to light waves beyond the physiological range of human visual perception must be mentioned. The human auditory organ has a potential physiological perception variation from 16 to 20,000 cps.[1] Musical instruments produce sounds that range between 40 and 4000 cps. At this point, it might be interpolated that there are interesting phenomena not readily explained which account for the fact that civilization has automatically limited the sonic range to about 15,000 cps. Anthropologists point out the fact that acoustical range is greater among primitive peoples. Ultrasonic waves have been demonstrated to have some very significant characteristics. A sound wave of 1000 cps. in the air has a length of 33 cm. The same wave through water has a length of 147 cm. An ultrasonic wave of 40,000 cps. in the air has a length of 8.2 mm. The same wave transmitted through water has a length of 36.7 mm. This variation depends on the differences of resistance of the conducting bodies. Despite the fact that ultrasonic frequencies are beyond the range of human perception, they have tremendous biological significance and impact on man because of their effect on human tissue.

PHYSIOLOGICAL EFFECTS OF ULTRASONICS

Laboratory investigation everywhere in the world continues to add its illuminating information about the effect of ultrasonic vibrations on the body tissue. New avenues of investigation are being opened up by ultrasonics in the study of bone changes, which heretofore have never been understood or satisfactorily explained. These new investigations, for example, have shown that ultrasonic sound waves in their passage through body tissues caused distinct alteration in the hydrogen ion concentration and in intratissue temperature. There is an initial alkaline shift in hydrogen ion which later reverses itself to produce a localized acidosis. There already is sufficient experimental substantiation that exposure to ultrasonic vibrations produces temporary alkaline shift in hydrogen ions that reaches a peak,

1. Müller, J.: Elements of Physiology, translated by W. Baly, Ed. 2, London, Taylor & Walton, 1843, Vol. 2.

stays at a plateau, and then subsides to normal in about four hours.[2] The change in the hydrogen ion concentration is a direct response of body tissue to the impact of ultrasonic waves. It is interesting to note that short consecutive exposures do not produce an additive, cumulative effect. It is of further interest to note that the intensity of ultrasonic waves is not of primary significance in influencing the degree of alteration in hydrogen ion concentration.[3] Human blood when exposed to ultrasonic wave vibrations for 10 minutes shows a diminution and concentration of the whole plasma protein, with a shift of the alpha, beta, and gamma fractions, with particular increase of the gamma fractions. Blood, thus exposed to ultrasonics, has been studied by Weltmann's coagulation method.[4] Blood exposed to ultrasonic vibrations shows definite alteration in characteristics which may have great potential clinical significance. The Weltmann serum coagulation reaction differentiates inflammatory from fibrotic changes. There is great prognostic as well as diagnostic potential in this new analytical determination. Disease is reflected in the changes of this coagulation band in the presence of acute inflammatory or exudative disease. In inflammatory disease, there is a decided shift to the left, or a shortening of the band. In parenchymal disease and in certain fibrotic conditions, there is a shift to the right. The explanation for this lies in the qualitative changes in serum protein, particularly the gamma portion of the globulin fraction. The biological response to ultrasonic stimulation is an increase of gamma globulin. Proteins are split by ultrasonic waves in an irreversible manner, not unlike the effect of ultraviolet and alpha rays on protein. These observations are further confirmed by electrophoresis.[4]

There is limitless substantiation for mechanical, thermal, and chemical effects of ultrasonic waves on body tissues. The mechanical effects are easily demonstrated by their capacity to destroy micro-organisms and by their ability to split molecular polymers. A 10-second exposure to ultrasonic waves of 20,000 cps. is sufficient to kill a fly. A three-minute exposure will kill a caterpillar. Larger animals have been destroyed by longer exposures to ultrasonics. White mice placed in a sound field and exposed to a frequency of 20,000 cps. at an acoustical level of 160 db. died after one minute of exposure. Mice whose fur was removed lived two and one-half minutes longer in a sound field; there was greater absorption in the fur, and consequently quicker death was noted. Insects were found to die more quickly while in clumps than when isolated. This is due to the fact that sounds tend to bring the insects into a tight clump, with increased intensity of heat in the narrow spaces between contiguous insects.[5]

A finding of great significance is the fact that ultrasonic waves produced by a siren have caused immediate, though temporary, hearing loss up to 70 db., despite the use of conventional ear mufflers. It was impossible to completely avoid exposure to radiated sound while working with experimental animals, even with protective ear molds. One effect noted in man, by the investigator himself, was a loss of

2. Hornykiewitsch, T., and Schulz, G.: Physikalische-chemische Untersuchungen über die biologischen Wirkungen des Ultraschalls, Strahlentherapie **82**:425, 1950.

3. Ludwig, G.: Velocity of Sound Through Tissue and Acoustic Impedance of Tissue, J. Acoust. Soc. America **22**:62, 1950.

4. Stuhlfauth, K.: Ultraschallwirkung an menschlichen Plasmaeiweiss, Ultraschall in Med. **3**:189, 1951.

5. Allen, C.; Frings, H., and Rudnick, I.: Some Biological Effects of Intense High Frequency Airborne Sound, J. Acoust. Soc. America **20**:221, 1948.

equilibrium with slight dizziness. This occurred even with exposure to intense audible sound. Investigators noted, at both audible and inaudible frequencies, tickling sensations in their noses while they were exposing animals to supersonic and ultrasonic vibrations. Extreme fatigue was a concomitant effect experienced by the investigators when using high frequency sound. These points are included only to emphasize the wide range of physiological changes which might be attributable to ultrasonic exposure. We must consequently reiterate the fact that ultrasonic vibrations may insidiously be causing changes in human tissue exposed to sound normally considered to be innocuous.

The chemical effect of ultrasonic waves is manifested in ion displacement and oxidation. The changes mentioned above in the protein molecules are considered to be chemical effects. The thermic effect has been demonstrated particularly in the high frequency ranges up to 750,000 cps. Even sonic ranges of the borderline (18,500) cycles per second have provoked a similar effect. Ultrasonic sounds and their effect on bony media have demonstrated important specific properties both of sound and of bone. Investigations have shown that ultrasonics resisted by bony media can cause a temperature increase of 10 degrees (C.) in that medium. Lower frequency sonics, of 18,500 cps. at 150 db., can cause a temperature increase of 10 to 15 degrees (C.) in an exposed guinea pig. That low frequency ultrasonic waves are of great importance has been adequately demonstrated by the production of liquefaction in thixotropic gels in cellular tissue.[6] This liquefaction tends to increase the permeability of the individual cell membrane, which is then responsible for changes in protein components and sol-gel balance within the cell. All ultrasonic waves are closely intermingled with sonic waves within the range of human perception.

This becomes particularly significant in the realization that sounds considered innocuous may, by their supersonic components, have a deleterious effect on the cochlea and the hearing mechanism. This may be especially significant in persons who have some predilection on a hereditary basis. Our entire world is surrounded by acoustical phenomena: insects, fish, animals of all kinds. They all create sonic and ultrasonic waves with frequencies ranging from 8,000 to 80,000 cps.[7] The jingling of keys, the honking of a horn, a whistle, a roaring train, all seemingly benign sounds, have ultrasonic overtones ranging from 20,000 to 80,000 cps. These are in addition to the sonic frequencey of 10,000 to 20,000 cps. These imperceptible sound waves have a definite impact on the hearing organ.[8] The effect of these sounds has been taken for granted, and for a long time the suggestion that ultrasonic vibrations may have a permanent damaging effect on the cochlea has been completely disregarded. Ultrasonics have been shown to cause distinct alteration in collagenous and bony tissue. Collagenous tissue exposed to sonic vibrations of 7500 cps. showed changes similar in character to those shown by collagenous tissue exposed to ultrasonic changes up to 750,000 cps. This is astonishingly significant, since the sonic ranges have never before been considered to have any harmful effects on normal tissue.[9]

6. Schmid, G.: Die erste Ultraschalltagung in Erlangen, Naturwissenschaft, p. 14480, 1950.

7. Busnel, R. G., and Chavasse, P.: Recherches sur les émissions sonores et ultrasons, Nuovo cimento, Supp. 7, p. 2, 1950.

8. Chavasse, P., and Lehman, R.: Les ultrasons dans la vie courante: Recherche et analyse, Nuovo cimento, Supp. 7, 1950.

9. Pohlman, R.: Über die mechanische and chemische Festigkeit biolog. Substanzen usw., Ultraschall in Med. **2**:26, 1951.

COLLAGENOUS SCLEROSIS EXPERIMENTALLY PRODUCED

In 1950, Palm [10] demonstrated an interesting alteration in the tissue of a rabbit's ear following as a result of exposure to ultrasonic vibrations. There was a marked thickening of the skin, a thickening of the collagenous tissue, and cartilaginous proliferation. The same tissue when exposed for the second time to ultrasonic waves showed extension of the tissue pathology. The surface tissue became necrotic and was accompanied by a tissue exudate. On the fourth day following the second exposure, the collagenous fibers began to deteriorate. In the third week after this reexposure, the collagenous tissue layers were converted to a loose structure with submiliary granulation and capillary buds. Two months after exposure there was a complete rearrangement of collagen in the deeper layers. There was increased capillary formation. Two weeks later, during the third month, there were signs of definite sclerosis in the collagenous structures. A chaotic network of fibrils of considerable thickness was found. The blood vessels were partially obliterated. The cartilaginous cells contained numerous granules as a result of the destruction of collagenous fibrils. This collagenous sclerosis was the end-result of experimental exposure and reexposure to ultrasonics. Initial thickening of the fibrils was produced, followed by proliferation of cartilaginous tissue, granulation on the capillary buds, and finally progressive destruction of the collagenous structure ending in sclerosis.

ULTRASONIC VIBRATIONS AND OTOSCLEROSIS

This experimentally produced collagenous sclerosis resembles the pathology found in otosclerosis. In 1878, H. Schwartze,[11] one of the first investigators and reporters of the pathology in otosclerosis, found that the deep connective tissue, normally arranged in layers of discrete fibrillae, appeared in the form of homogeneous opaque bundles, with interspaces filled with scattered encapsulated cells and finely granulated masses. The pathological changes in bone produced by ultrasonic exposure are interesting and noteworthy. Since bony tissue is rich in sol-gel substances, a study of the effects created by exposure to ultrasonics is particularly enlightening. Short wave vibrations similar to those used in diathermy produce thermic energy which is uniformly distributed throughout any of the exposed tissue. The thermic energy effects of ultrasonic wave vibrations, however, are localized and concentrated at the margins and periphery of the exposed tissue. This is a significant differentiation in the alteration of tissue by short wave as compared with the alteration by ultrasonic wave vibration. This well-established change in the periphery of tissue is therefore responsible for the fact that in bone the periosteum and endosteum, namely the marginal layers, are first and most intensively altered by exposure to ultrasonic waves.[12] The endosteum particularly responds to ultrasonic wave exposure by the production of a marginal fibrosis, which is later followed by sloughing. The periosteum, which is sensitive to ultrasonic waves, responds and reacts with an initial thickening and proliferation of the connective tissue cells, which are

10. Palm, M.: Histologische Gewebsveränderungen nach der Einwirkung von Ultraschall, Strahlentherapie **82**:445, 1950.

11. Schwartze, H.: The Pathological Anatomy of the Ear, translated by J. O. Greene, Boston, Houghton, Oosgood Company, 1878, p. 11.

12. Bruener, H., and Rindfleisch, H.: Zur Wirkungsmechanism des Ultraschall, Ultraschall in Med. **2**:136, 1950.

subsequently linked by newly formed filaments. The intracellular substances later become more dense. The cells decrease in size and number, and finally even an osteoid tissue which displays very distinct characteristics is formed. In contrast to the normal bony tissue, the plane of the new bony framework is not longitudinal in terms of the entire bony structure. This newly formed osteoid tissue is marked by areas of liquefaction.[13]

The morphological changes in bony tissue produced by ultrasonics are accompanied by thermal changes. Biquard [14] first recorded the thermic phenomena due to the diffusion of liquids after ultrasonic wave exposure. The thermic effects of ultrasonics on bony tissue were studied by embedding fresh bone in agar-agar and exposing this to ultrasonic waves. The greatest temperature rise, 10 degrees (C.), was recorded at the outer margins of the bony tissue, regardless of whether high or low frequency ultrasonics were used.[15] This marginal or surface effect is due to a most important characteristic of ultrasonic waves—namely, that ultrasonic waves are reflected as they pass from one medium to an adjacent medium. The effects of this reflection of ultrasonic waves upon the tissue "partition" between two different media have been dramatically demonstrated on the spleen. The ultrasonic waves conducted through this organ were reflected at the margins of the capsule. This resulted in a subcapsular necrosis. The bluish-red discoloration of a bulbous vertebra after ultrasonic wave exposure is one of the most significant of Lehman's findings.[16] A similar bluish-gray discoloration of the myelin sheath, accompanied by granular deterioration, was noted after exposure to ultrasonics.[17] Would it be far afield, therefore, to speculate that the so-called blue coats of Manasse, which were noted and described so thoroughly in the study of otosclerosis, might possibly be due to this ultrasonic phenomenon?[18] The sequence of morphological changes in otosclerosis have been studied thoroughly. An initial phase is characterized by a proliferation of immature, bluish-tinted bony tissue, with a few fibrils but rich in collagenous substance. This phase is followed by the appearance of otosclerotic foci originating in the endochondral layer and progressing in the form of exostoses of soft consistency.

There is a striking similarity between the histological findings in otosclerosis and those which were produced experimentally by exposure of bone to ultrasonic wave vibrations. These changes in the periphery of bony tissue are so suggestive of otosclerosis that it can be speculated that they are one and the same. The structural changes of otosclerosis pass through several distinct phases. As yet these changes are initiated by undetermined stimuli. It is interesting to note that the speed and the degree of change from the normal to the pathologic in otosclerosis

13. Buchtala, V.: Die Ultraschallwirkung auf dem wachsenden Knochen: Histologischer Teil, Strahlentherapie **80**:317, 1949.

14. Biquard, P.: Sur l'existence des ondes ultrasons dans les liquids, Compt. rend. Acad. sc., p. 202, 1936.

15. Theisman, H., and Pfander, F.: Über die Durchlässigkeit des Knochens für Ultraschall, Strahlentherapie **80**:607, 1949.

16. Lehman, J.: Temperaturabhängigkeit therapeutischer Ultraschallreaktionen, Ultraschall in Med. **2**:31, 1950.

17. Peters, G.: Ultraschallwirkung auf das Nervensystem, Ultraschall in Med. **2**:554, 1950.

18. Nager, F. R., and Rüedi, L.: Histologische Untersuchung der Fenestrationsplitters bei Otoskleroseoperation, Acta oto-laryng. **39**:300, 1951.

are determined by the rapidity, the extent, and the effectiveness of the body's defense reactions to multiple stimuli. Irreversible damage may be caused by inadequate defense of the organism to these stimuli.

Another stimulative thought is that the human body responds to physiological and emotional stress with an increased production of corticotropin. It has been established that osteoporosis is one of the early manifestations and often the first alarm reaction to stress.[19] It has also been substantiated that exposure to ultrasonic waves stimulates the production of corticotropin as an initial alarm reaction.[19] When there is depletion of corticotropin after multiple stresses, the process reverses itself, and then the defense production of fibrosis and sclerosis occurs. There is first an alteration and then an increased fibrotic tendency manifesting itself in an effort to seal off and protect the injured areas.

COMMENT

These are but a few of the limitless exciting findings of scientific investigators culled from the world literature on this disease. Ultrasonic vibrations are a factor to be reckoned with in our physiological economy. In specific areas, such as bone pathology and otosclerosis, time, patience, and respect for this new biological entity may be scientifically compensating.

Otosclerosis has for years defied the brilliant investigation of the embryologist, histologist, pathologist, and clinician. Despite the remarkable surgical progress in deafness caused by otosclerosis, the disease itself is today as baffling as when it was first described. Hereditary predisposition, sites of predilection, age of onset are still areas for speculation without substantiation. The answers may lie in a newer scientific concept which, even though speculative, may stimulate enlightening investigation. The study of ultrasonic vibrations is a new investigative medium which has already been shown to cause significant mechanical, chemical, and thermal effects on body tissue. Pathological changes in bone after exposure to ultrasonics have shown interesting, and at times remarkable, resemblances to the process of otosclerosis. Certainly these changes deserve either substantiation or denial by further specific studies on the temporal bone.

Sonic and ultrasonic vibrations surround us constantly in every phase of normal activity. Sounds hitherto accepted as innocuous have ultrasonic components. Their effect on the footplate of the stapes, the cochlea, the labyrinth, the region of Corti has never been considered. The possibility of a hereditary predisposition or hypersensitivity in bone may be a contributing factor in the specific family occurrences of otosclerosis. A low hormonal resistance or reserve may be a significant predisposing factor when subjected to ultrasonic vibrations.

The undeniable alteration of bone by ultrasonic vibrations may open new vistas for investigations of otosclerosis. The solution to this disease, which has baffled, confused, and resisted investigation by conventional approaches, may well lie in this newer scientific discipline of ultrasonic vibrations. A new biological approach to the study of hearing deficiencies and otosclerosis is therefore suggested by the newer studies and advances of experimental physiology with ultrasonic frequencies.

162 E. 80th St.

19. Dova, E., and Bussi, L.: Sull' effeto di "Stress" degli ultrasoni, Nuovo cimento, Supp. 7, p. 487, 1950.

REPAIR OF CENTRAL PERFORATIONS OF TYMPANIC MEMBRANE

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THE REPAIR of central perforations of the tympanic membrane has received practically no mention in current textbooks of otolaryngology and had received relatively scant attention in the literature prior to World War II. However, rupture of the tympanic membrane as a wartime injury focused much more interest on the closing of perforations, and a review of the literature during and after World War II is much more rewarding on this subject.

Although Marcus Banzer [1] is generally mentioned as the first, in 1640, to propose a prosthesis treatment, Yearsley [2] was the first to seal over eardrum perforations with cotton-wool pledgets. Afterward came Toynbee's [3] rubber disc as a patch prosthesis. The principle of patch therapy is much in use currently, and the present favorites seem to be various thin papers or Cargile's membrane.

The other important principle in eardrum repair, acid cautery of the perforation margins, was introduced by Roosa's [4] use of silver nitrate and Okuneff's [5] success with trichloroacetic acid. Joynt [6] was apparently the first to combine prosthesis and cautery treatment in four successful closures, in 1919. This combined treatment with some variation in the type of patch material and destruction of the epithelial perforation margin, either by trichloroacetic-acid or silver-nitrate cautery or by scarification,[7] has been used almost universally in the past 10 years, judging from

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Candidate's thesis submitted in partial fulfillment of the requirements for membership in the American Laryngological, Rhinological and Otological Society.

1. Banzer, M.: Dissertation on Deafness, 1640.

2. Yearsley, J.: Deafness Practically Illustrated: Being an Exposition of Original Views as to the Nature, Causes, and Treatment of Diseases of the Ear, Ed. 6, London, John Churchill and Sons, 1863.

3. Toynbee, J.: On the Use of an Artificial Membrana Tympani in Cases of Deafness, Dependent upon Perforation or Destruction of the Natural Organ, Ed. 6, London, J. A. Churchill, Ltd., 1857.

4. Roosa, D. B. St. J.: A Practical Treatise on the Diseases of the Ear, Including the Anatomy of the Organ, Ed. 3, New York, William Wood and Company, 1876.

5. Okuneff, W. N.: Über die Anwendung des Acidum trichloraceticum bei chronischen eitrigen Entzündungen des Mittelohres, Monatasschr. f. Ohrenh. **29**:1-14 (Jan.) 1895.

6. Joynt, J. A.: Repair of Drum, J. Iowa M. Soc. **9**:51 (Feb.) 1919.

7. (*a*) Baron, S. H.: The Repair of the Ear Drum in Blast Injuries, Ann. Otol. Rhin. & Laryng. **57**:143-152 (March) 1948. (*b*) Jordan, L. W.: Traumatic Rupture of the Tympanic Membrane, Laryngoscope **62**:615-622 (June) 1952. (*c*) Hall, A.: Prosthesis Treatment and Its Healing Effect on Central Perforations of the Tympanic Membrane, Acta oto-laryng. **39**:136-150, 1951.

the reports of Stinson,[8] Alexander,[9] Fox,[10] Ireland,[11] Korkis,[12] Folbre,[13] Baron,[7a] Adams,[14] and Jordan.[7b]

Surgical repair of perforated drum membranes was proposed by Berthold[15] in 1878, and a modified technic was used successfully by Shulhof and Valdez[16] in 1944. The paucity of published reports on surgical attempts makes it difficult to evaluate this technic for closure. The same statement holds true for three successful drum closures by Griot's[17] technic, reported in 1931, of blowing hot air against a perforated drum membrane until the drum is quite reddened.

Dependence upon an artificial membrane alone as a means of treatment has been reported as recently as 1943 by Nasiell[18] and 1945 by Steinmann,[19] both of whom used cellophane, with some successful closures resulting. In 1951 Hall[7c] reported the use of the patch prosthesis of "Yoshino paper," cemented in position with a 5% solution of celluloid in acetone, without cautery or scarification in the majority of 176 treated cases. This author's success in treating 30 traumatic perforations was remarkable, with 29 healed perforations. However, Hall's record of only 30 successful closures in treatment of 146 perforations which had resulted from otitis media does not compare well with the work of other authors.[20]

My own study of the repair of central perforations of the tympanic membrane was begun in 1946 at the suggestion of Shambaugh,[21] who called my attention to an article by Linn[20a] upon my return from military service overseas to civilian practice.

A personal demonstration of his technic by Linn upon two of our patients, while he was in Chicago in June, 1946, made me thoroughly familiar with his technic of

8. Stinson, W. D.: Closure of Perforations of Membrana Tympani with Cargile's Membrane, Ann. Otol. Rhin. & Laryng. **50**:178-181 (March) 1941.

9. Alexander, A. B.: Blast Injuries to the Ear, M. Press **209**:249-251 (April 21) 1943.

10. Fox, S. L.: On Closing Tympanic Membrane Perforations, South M. J. **38**:492-493 (July) 1945.

11. Ireland, P. E.: Traumatic Perforations of Tympanic Membrane Due to Blast Injury, Canad. M. A. J. **54**:256-258 (March) 1946.

12. Korkis, F. B.: Rupture of Tympanic Membrane of Blast Origin, J. Laryng. & Otol. **61**:367-390 (July) 1946.

13. Folbre, T. W.: Blast Rupture of the Tympanic Membrane, Texas J. Med. **43**:397-400 (Oct.) 1947.

14. Adams, L. A.: Closure of Tympanic Membrane Perforations by Trichloroacetic Acid Cauterization: Report of Cases, A. M. A. Arch. Otolaryng. **55**:38-42 (Jan.) 1952.

15. Berthold, E.: Über Myringoplastik, Med.-chir. Centralbl. **14**:195-207, 1879.

16. Shulhof, E., and Valdez, G.: Pathology and Therapeutics of the Perforated Eardrum, Lecture, read before the Franco-Mexican Medical Association, Aug. 3, 1944.

17. Griot, G. A.: Old Perforations Closed by the Use of Heat, Nebraska M. J. **16**:402-403 (Oct.) 1931.

18. Nasiell, V.: Demonstration of Application of Artificial Tympanic Membranes According to New Principles: (Fixed Transparent Prosthesis of About Membrane Thickness for Permanent Use), Acta oto-laryng. **20**:432-443, 1934.

19. Steinmann, E. P.: Über die Verwendung der "Cellophane" für Trommelfellprosthesen, Praxis **34**:647-652 (July) 1945.

20. (*a*) Linn, E. G.: Closure of Tympanic Membrane Perforations, Eye, Ear, Nose & Throat Month. **23**:185-187 (May) 1944. (*b*) Adams.[14] (*c*) Dunlap, A. M., and Schuknecht, H. F.: Closure of Perforations of the Tympanic Membrane, Laryngoscope **57**:479-490 (July) 1947.

21. Shambaugh, G. E., Jr.: Personal communication to the author.

closure. It consisted of thorough repeated cautery of the entire edge of the perforation with saturated solution of trichloroacetic acid applied with a small, tightly wound cotton-tipped applicator, followed by the application of a pledget of cotton which had been dipped in "protonuclein" powder and irradiated by ultraviolet light to "activate" the powder. The cotton pack was moistened with Euthymol and pressed firmly against the eardrum. (Euthymol is a proprietary mixture of eucalyptol, methyl salicylate, menthol, thymol, boric acid, and benzoic acid in 20% alcohol, made by Parke, Davis & Company.) Two drops of Euthymol was instilled into the ear twice daily. This treatment was repeated every six days until the perforation was healed.

From April, 1946, until August, 1952, I attempted to close a total of 143 permanent perforations of the tympanic membrane, selecting as suitable those that were central, with a definitely visible periphery of pars tensa remaining around the entire circumference of the annulus tympanicus and with the middle-ear cavity lined by mucosa. No restriction was placed upon the size or the duration of a central perforation selected for treatment. Perforations which partially surrounded the malleus-handle insertion were not excluded, nor were those in which the margin of the perforation was at different planes,[7a] as long as no adhesion of the margin or malleus to the mucosa of the promontory was evident.[7c] Mastoid disease, including cholesteatoma, complete loss of pars tensa, or even partial marginal involvement, and persistent obstruction of the Eustachian tube, were definite contraindications to attempted drum repair. The treated ears were dry at the beginning of the closure treatment, but many had needed local treatment, adenoidectomy, or, most important of all, control of a nasal and/or aural allergy[22] by proper allergic management, before a dry ear could be obtained and maintained.

Each patient considered for closure treatment had an audiogram when first seen with a discharging ear, again when the ear was dry, and, finally, when the perforation was proved to be healed by pneumomassage with the Brunings-Zeiss otoscope and by Politzer inflation with no escape of air. In the majority of cases the dry perforations were tested with a cigarette-paper patch prosthesis in an attempt to predict the approximate hearing gain to be expected. At each treatment, the size of the perforation was estimated, often with the aid of the fenestrometer, which is a 4-mm. ruler used to measure the completed fenestra during the fenestration operation (Fig. 1); the presence of any secretion was noted, and the exact technic used, with any modifications, was recorded.

My original intent was to follow the closure technic of Linn, omitting the use of irradiated protonuclein powder and substituting a mixture of sulfanilamide, sulfathiazole, and sulfadiazine powders with Sulzberger powder (iodine and boric acid). I could find no substantiation for Linn's assumption of the healing properties of irradiated protonuclein powder in the process of drum repair and therefore chose to omit this powder. However, the use of sulfonamides as a protection against infection in a technic which was certainly not a sterile one seemed to have a definite indication, and their use in the early management of ruptured eardrums had been

22. (*a*) Koch, H.: Allergical Investigations of Chronic Otitis, Acta oto-laryng., Supp. 62, 1-201, 1947. (*b*) Derlacki, E. L.: Aural Manifestations of Allergy, Ann. Otol. Rhin. & Laryng. **61**:179-188 (March) 1952.

advised by Alexander,[9] Palmer,[23] McReynolds and associates,[24] and Silcox and Schenck.[25] During the period of the study other authors' ideas influenced the original technic, and thus a number of modifications resulted, which will be described later in the paper.

Soon after my study was begun, it became apparent that certain questions concerning the closure treatment were important to the patient, and at first, I could not answer them. Patients are much more willing to persevere in a tedious repetition of treatments if they know the chances for successful closure, the chances for recurrence of the perforation, how much improvement in hearing can be expected, and how many treatments will be necessary.

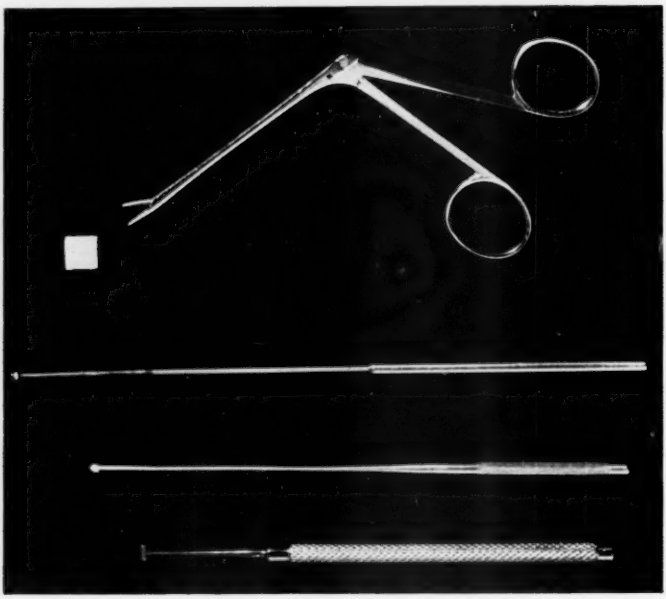

Fig. 1.—Instrumentarium: Top, alligator ear forceps for placing 9-mm.-square cotton patch shown at tip of forceps; next, diamond curette, designed by Drs. Arthur L. Juers and Charles F. Whitaker, Jr., and used for scarification; third, tiny cotton-tipped applicator for trichloroacetic-acid application; last, fenestrometer, 4 mm. long and graded in 0.5 mm.

ANATOMY AND HISTOPATHOLOGY

The tympanic membrane is slightly oval and varies in size from 8 by 9 mm. to 9 by 10 mm. in the adult. The tense portion consists from without inward of four sheet-like lamellae:

1. An outer thin cutaneous layer of stratified squamous epithelium.

2. A connective-tissue layer of radiating fibers from the manubrium to the fibrocartilaginous annulus tympanicus.

23. Palmer, C. W.: Blast Perforation of Ear Drums, Brit. M. J. **2**:233 (Aug. 21) 1943.

24. McReynolds, G. S.; Guilford, F. R., and Chase, G. R.: Blast Injuries to the Ear: The Texas City Disaster, Arch. Otolaryng. **50**:1-8 (July) 1949.

25. Silcox, L. E., and Schenck, H. P.: Blast Injury of the Ears, Arch. Otolaryng. **39**:413-420 (May) 1944.

3. A second connective-tissue layer, its fibers arranged concentrically, best developed at the annulus. The two fibrous layers are closely united.

4. A mucous layer of pseudostratified columnar or cuboidal epithelium, a portion of the mucosa of the middle-ear cavity.

The majority of permanent central perforations of the tympanic membrane are the end-result of the process known as acute necrotic otitis media. This condition occurs predominantly in children during an acute febrile illness, such as scarlet fever or measles. An intercurrent otitis media may then take the necrotic form, with sloughing of part or even all of the tympanic membrane. A considerable number of ears may persist in discharging because of chronic allergic otitis media. A minority of the permanent perforations result from traumatic causes such as those listed by Hall.[7c]

Dunlap and Schuknecht [26] and Guild [27] have excellent photomicrographs showing that the permanency of a central perforation is maintained by the epithelialization of its margin by the outer cutaneous layer's having grown inward to meet the mucous layer. This opening may be compared to epithelial tracts or fistulae elsewhere in the body, such as an oral-antral fistula. It is a firmly established surgical principle in eradication of a fistula that the entire epithelial lining must be destroyed in order to allow connective tissue to reestablish continuity. The rationale for complete destruction of this epithelial barrier in any closure treatment of permanent central perforations by acid cautery or scarification is obvious. Not so obvious is the mechanism of healing after the destruction of the limiting epithelium has been accomplished. Since serial histopathologic studies of a healing drum perforation are not available, the divergence of opinion concerning which drum layer [28] is the dominant one in healing will not be answered by clinical observation of a series of successful closures.

Stinson's [28a] suggestion of the outer epithelial layer as the active one may explain the healing of perforations resulting in thin atrophic scars with only the outer epithelium and inner mucous layer participating. The atrophic scars, in my experience, have usually resulted from the spontaneous healing of old perforations or, less frequently, from successful closure by the use of a cigarette-paper patch prosthesis without cautery.

When the process of drum healing has resulted in newly regenerated drum membrane, which appears normal in thickness and in elasticity when moved by Politzer inflation or by drum massage with the Brunings-Zeiss otoscope, I cannot tell which layer was the most important in healing. Dunlap and Schuknecht [20c] state that epithelial-tissue destruction by acid incites an inflammatory healing response in the middle layer (connective tissue) of the drum margin, with fibroblastic proliferation laying down interlacing fibers of collagen, which shorten when they are

26. Dunlap, A. M., and Schuknecht, H. F.: Closure of Perforations of the Tympanic Membrane, Laryngoscope **57**:479-490 (July) 1947.

27. Guild, S. R.: Interpretation of Hearing Tests with Special Reference to Conduction Deafness, J. A. M. A. **142**:466-469 (Feb. 18) 1950.

28. (*a*) Stinson, W. D.: Reparative Processes in the Membrana Tympani: Some Interesting Manifestations, Arch. Otolaryng. **24**:600-605 (Nov.) 1936. (*b*) Dunlap and Schuknecht.[20c] (*c*) Hall.[7c]

completely formed. The resultant shrinking of this circular band of fibers may facilitate closure by purse-string action. Hall,[7c] on the other hand, advances the mucous membrane as the most important in healing, stating that in his opinion, "The most important thing needed to attain healing is a normal or increased formation of blood vessels in the mucous membrane of the middle ear. It is the increased supply of blood to the edge of the perforation with the consequent formation of new

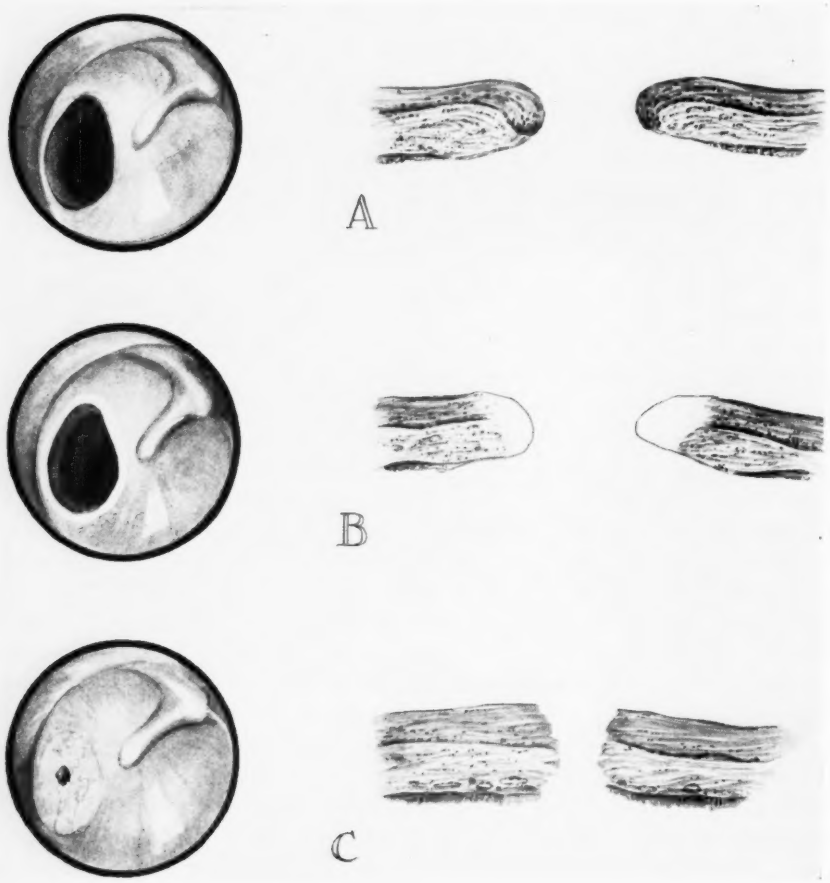

Fig. 2.—Diagrams from Kodachrome photographs taken for me by Dr. Linden J. Wallner and depicting: *A*, untreated permanent central perforation; *B*, eschar around margin of perforation from trichloroacetic-acid cautery; *C*, healing perforation with actively granulating margin and newly formed drum tissue. Diagrams at right depict my conception of cross section of comparable stage. Uppermost layer is epithelium, which in *B* is thoroughly cauterized.

blood vessels that break through the epithelium barrier and which keeps step with the proliferation of the epithelium surface." My own impression is that both the mucous membrane and the middle connective-tissue layer contribute importantly to the concentric red granulating edge of a successfully healing perforation (Fig. 2).

CLASSIFICATION OF PERFORATIONS ACCORDING TO ETIOLOGY

The central perforations of the tympanic membrane treated in my series can be divided into: (1) traumatic and (2) inflammatory.

Fourteen cases of traumatic perforation could be divided as follows:

A. Eight cases of tympanic membranes perforated during fenestration, in all of which the perforation failed to show any tendency to heal with repeated applications of cigarette-paper patches over periods varying from 6 weeks, as the shortest trial in one case, to 18 months, as the the longest trial in another case.

B. Six cases of eardrums perforated by such varied causes as: (1) burn by hot metal slag, (2) skull fracture and cerebral concussion with bleeding from ear at time of injury, (3) explosion of toy balloon, (4) patient struck by lightning, and (5) ear syringed for removal of cerumen in two cases. Three of these eardrums had undergone a trial with a cigarette-paper patch prosthesis with no improvement over a period of months. These were all permanent perforations, the shortest duration having been 10 weeks.

One hundred twenty-nine inflammatory perforations could be divided into:

A. Those due to benign chronic suppurative otitis media with a superficial specific infection of the mucosa of the middle ear and Eustachian tube. The ears were either dry when first seen or responded quickly to careful cleaning of the middle ear, tubal inflation, and local medication. Eighty-three of the perforations were so classified.

B. Forty-six perforations associated with allergic chronic suppurative otitis media as described by Koch [22a] and Derlacki.[22b] In these cases a longer period of allergic management was necessary to obtain dry ears, and in most of them the allergic care had to be maintained during the period of closure treatment.

TECHNIC

The entire margin of the perforation is carefully touched with a tiny, tightly wound cotton-tipped applicator (Fig. 1), which has been moistened with a saturated solution of trichloroacetic acid. Any excess of acid is removed from the cotton by touching it to absorbent tissue paper. The acid application is directed against the epithelium lining the edge of the perforation and is extended out upon the epithelial surface for a distance of at least 0.5 to 1 mm., producing a solid white eschar. If care is taken to avoid touching the middle-ear mucosa of the promontory, I do not find a topical anesthetic solution to be necessary even in children. The acid application is followed by a light insufflation of the mixture of trisulfonamides and Sulzberger powder mentioned before (Fig. 3).

The entire tympanic membrane is then covered with a thin, flat cotton patch, about 9 mm. square, which is inserted down to the eardrum with an alligator ear forceps (Fig. 1). The cotton is moistened with 3 or 4 drops of Euthymol dropped into the ear canal, and the moistened pledget is then tamped snugly down against the drum. The patient keeps the cotton moistened by twice-daily insertion of 2 drops of Euthymol into the ear canal between treatments. Euthymol was used empirically in adhering to parts of Linn's [20a] technic. No especial virtue, which could not be obtained in another mixture, can be claimed for this mildly antiseptic and locally irritating solution.

The use of the cotton patch moistened with an irritant solution has, in my mind, the following advantages:

1. The mild sterile inflammatory reaction produced, with the increased vascularity, is a stimulus to healing. That the much more intense reaction of inflammation produced by an inter-

current otitis media often gives impetus to a lagging healing effort during closure treatment has been observed in our series as well as by many others.[29]

2. Correct placement of the cotton patch results in improved hearing comparable in many cases to the improvement obtained with other patch prostheses and encourages the patient to continue this possibly tedious period of treatment to a successful conclusion.

3. The moistened cotton prevents the formation of a crust of dried exudate which may mechanically obstruct closure.[30]

The process as outlined was originally repeated once a week, since both Linn [20a] and Dunlap and Schuknecht [20c] believed that the epithelium would grow over the perforation in about one week. However, this regrowth of epithelium can vary considerably, since I found that, not infrequently, the closure treatment proceeded steadily to successful healing with an interval between treatments of 10 days, 2 weeks, and even, occasionally, 3 weeks in cases in which progress had failed to appear after four or five successive treatments at a 1-week interval. A lack of progress was also found when only a portion of the periphery of the perforation was showing a red, actively granulating edge at the removal of the cotton patch. The entire periphery must be active in order to produce progressive healing, and in five cases scarification of the inactive segments with a diamond curette (Fig. 1), prior to thorough cautery, resulted in the impetus necessary to complete repair of the perforation.

Another modification of the original method resulted from my learning of the use of urea solution by Dunlap and Schuknecht [20c] in January, 1947. Since that time I have used 5% urea in isotonic sodium chloride solution in a number of cases to produce sufficient inflammatory response when the Euthymol failed to do so. I later found cases in which Euthymol was, conversely, a more successful irritant than the urea. Occasionally, the use of either of the solutions twice daily caused too much irritation, resulting in a mucoid secretion, and the frequency of their use was reduced to once daily or once every other day. If a fairly profuse secretion has occurred from irritation, the cotton patch and ear drops are omitted for one week, but the acid cautery is carried out after thoroughly drying the ear canal and tympanic membrane. The ear will dry promptly in 24 to 48 hours, and the cotton patch can be used at the next treatment.

The middle-ear discharge from irritation can be differentiated from the severe allergic reaction which may develop to either one of the solutions or to the insufflated sulfonamides. The allergic reaction usually affects the middle-ear mucosa, the drum membrane, and the skin of the external auditory canal, with considerable swelling and an extensive weeping eczema. In three of my cases treatment had to be discontinued owing to this acquired sensitivity.

An intercurrent suppurative otitis media occurred in a few of the cases during treatment and always, in my experience, resulted from an acute infectious rhinitis and/or pharyngitis. The closure treatment is omitted in such cases until the otitis media has subsided completely under the appropriate systemic chemotherapy or antibiotic. In one case of my series, during a severe sore throat an otitis media developed and was followed by a suppurative meningitis, which cleared with the use of an adequate dosage of sulfadiazine administered orally and intravenously and penicillin given intramuscularly. The perforation is still under treatment and has closed about four-fifths from its original size.

29. Hoople, G. D.: An Otolaryngologist's Experience in World War II, Ann. Otol. Rhin. & Laryng. **55**:121-127 (March) 1946. Baron.[7a] Jordan.[7b] Dunlap and Schuknecht.[20c]

30. Dunlap and Schuknecht.[20c] Folbre.[13]

One problem was met in the series of perforations treated in my study which I have not found mentioned in the literature on the repair of perforated eardrums. This was the problem of the central perforation whose anterior-inferior margin was completely hidden by a tortuous external auditory canal with a high isthmus. No amount of manipulation or positioning of various sizes of ear specula would bring the hidden perforation margin into view. Four such cases were observed. The following case illustrates the problem.

CASE 1.—Mrs. E. M., aged 36, complained in August, 1946, of bilateral hearing impairment, present ever since a bilateral suppurative otitis media which had occurred during scarlet fever when she was 3 years of age. The tympanic membranes showed large central perforations, the

Fig. 3.—From Kodachrome photographs in two cases in series showing two perforations during course of treatment: *A*, perforation about two-thirds healing; *B*, same perforation with eschar after thorough trichloroacetic-acid cautery; *C*, another perforation, about one-half healed after six treatments, showing good granulating margin and increased vascularity of newly healed membrane; *D*, same perforation after thorough cautery; *E*, same perforation covered with thin cotton patch moistened with Euthymol. Color photographs were taken by Dr. Linden J. Wallner.

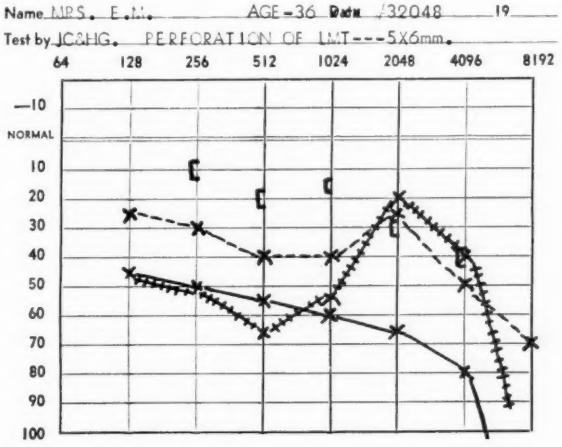

Fig. 4.—Audiograms, Case 1. Unbroken line, recorded May 3, 1948, shows preoperative hearing level with perforated left tympanic membrane; crossbarred line, recorded Aug. 13, level following fenestration and plastic procedure on ear canal with perforation still present; broken line, recorded Feb. 12, 1952, hearing with perforation healed for two years and eight months.

left being 5 by 6 mm. in its visible portion. Closure treatment was begun on Jan. 27, 1947, and by April 22 the remaining perforation, except for its posterior-superior edge, could not be seen, owing to the high isthmus of the ear canal. This treatment was followed by 12 months of fruitless attempts to activate the anterior and inferior edge by cauterizing blindly with a bent cotton-tipped applicator. With a patch on the perforation the air and bone audiograms and tuning-fork tests revealed a conductive deafness with complete stapes fixation due to a chronic adhesive process, and the case was considered as a "B" case in suitability [31] for the fenestration operation.

31. Shambaugh, G. E., Jr: Fenestration Operation for Otosclerosis: Experimental Investigations and Clinical Observations in 2,100 Operations over a Period of 10 Years, Acta oto-laryng., Supp. 79, pp. 1-101, 1949.

It was decided to combine the two necessary surgical procedures, and on May 4, 1948, I performed an uneventful fenestration in a sclerotic mastoid, following the Shambaugh technic.[31] As a part of the fenestration, the anterior tympanic plate and floor of the bony meatus were taken down more extensively than is customary, to permit complete visualization of the anterior and inferior annulus tympanicus and the perforation, 1.75 by 2.5 mm. of which remained. After the fenestration cavity was completely healed, the closure treatment was resumed, on Aug. 20, and proceeded very slowly and discouragingly. The total number of treatments before and after the fenestration and plastic operation was 64. The final hearing result, after closure

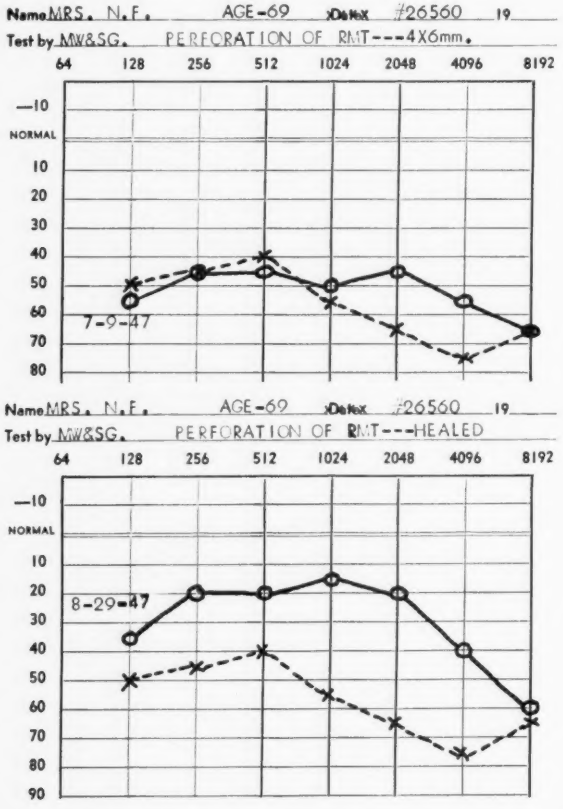

Fig. 5.—Audiograms in case of successful closure with satisfactory gain in hearing. Unbroken lines, with circles, show hearing in right ear. Top audiograms were recorded before, and bottom ones after, repair. Broken lines, with *x*'s, recorded for left ear, show hearing in that ear unchanged.

of the perforation, achieved partial rehabilitation (Fig. 4), which the patient considered worth while enough for her to request a subsequent attempt to close the other eardrum. This attempt ended in failure, in spite of rapid progress, because of an acquired sensitivity to both urea and Euthymol ear drops.

The next two ear canals encountered in which a high isthmus obscured a portion of the perforation were in one patient. Arthur L. Juers performed the bilateral

endaural plastic procedure on both ear canals in May, 1949. After elevating the skin of the canal, enough of the tympanic plate and the bony meatus inferiorly and superiorly was removed to obtain easy access to the anterior and inferior margins of the perforations. The elevated skin of the canal was replaced and kept in place by elastic sea-sponge pressure in a modified fenestration dressing. The canals were completely healed in about 10 days. Only one of the two perforations was healed by subsequent closure treatment. In November, 1950, I found it necessary to enlarge one other tortuous ear canal by the same surgical procedure. The perforation in this case was only about two-thirds closed when the patient had to discontinue treatment in order to take an advantageous job out of the city. The treatment trial, however, had been prolonged enough for his case to be classified as a failure.

The advantages to the patient of a successful repair of a perforated tympanic membrane are several, but the relative importance of these advantages depends somewhat upon the individual patient. In the majority of cases the desire for improved hearing is primary, particularly when the hearing threshold in both ears is considerably below the so-called practical level, a 30-db. average in the speech frequencies, and a patch prosthesis elevates the hearing into the practical level. When the hearing is not so seriously impaired, the intact drum may be sought to eliminate the danger of outside infection, as in swimming, or to reduce greatly the chance of a discharging ear during head colds. One elderly woman with a very satisfactory (to me) gain in hearing of 30 db. to an 18-db. level in her better ear from a successful closure (Fig. 5) was far more impressed by the complete relief of a very annoying tinnitus, which had been present for over 30 years. Occasionally closure of a perforation will make eligible for fenestration surgery an otosclerotic patient who would otherwise be disqualified because of the drum defect. Certainly the advantages accruing from a healed perforation would surpass those from a prosthesis, such as the tympanic insert advocated by Asherson,[32] in cases of a small permanent central perforation.

REPORT OF CASES

CASE 2.—F. C., a youth aged 20, complained in September, 1951, of an injury to the left ear suffered one year previously, when a red-hot chip of slag fell into the ear canal while he was working at an open-hearth furnace. A month of local treatment stopped the discharge which followed the injury. Afterward the patient noticed a mild hearing loss in the left ear, an annoying whistling in his left ear on blowing his nose, and, on one occasion, an attack of rotary vertigo when water entered the left ear canal during swimming. Examination revealed an almost total central perforation of the left tympanic membrane, measuring 7 by 7 mm. with the fenestrometer. There was 1.5 mm. of the end of the malleus projecting into the superior margin of the perforation. Six closure treatments with Euthymol as the moistening agent resulted in closure, with a 16-db. gain in hearing recorded on Nov. 24 (Fig. 6).

CASE 3.—D. S., a married woman aged 31, an otosclerotic patient who was an ideal candidate, had a fenestration operation on the left ear on Jan 13, 1952. A posterior-superior central perforation measuring 1 by 1.5 mm. was discovered three weeks postoperatively and treated with trichloroacetic-acid cautery and cigarette-paper patch prosthesis. This treatment was repeated twice in the next eight weeks, while the fenestration cavity was healing completely. The perforation grew in size to 3 by 5 mm. and the patient was upset by the partial loss of her

32. Asherson, H.: Deafness Due to Chronic Otorrhoea: Alleviated by Tympanic Insert, J. Laryng. & Otol. **64**:239-248 (May) 1950.

excellent hearing result when the patch migrated away from the perforation. Three closure treatments at two-week intervals, Euthymol ear drops being used, resulted in a successful repair, and hearing returned to the practical level (Fig. 7).

CASE 4.—J. B., a woman aged 22, complained in March, 1948, of recurrent bilateral otorrhea, present since childhood, with a noticeable hearing impairment in the past seven years.

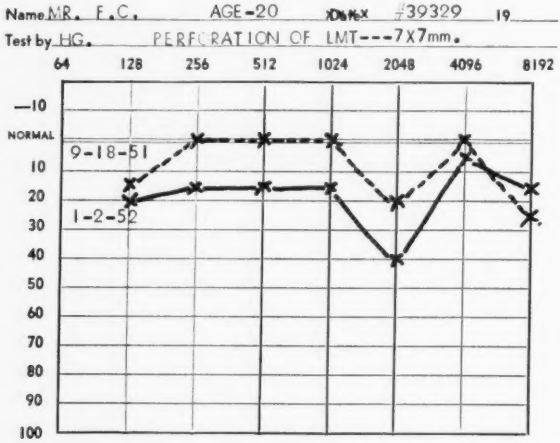

Fig. 6.—Audiograms, Case 2. Unbroken line represents hearing in left ear before treatment; broken line, hearing after healing of perforation in six treatments. Perforation, 7 by 7 mm., followed a burn from hot slag suffered one year previously.

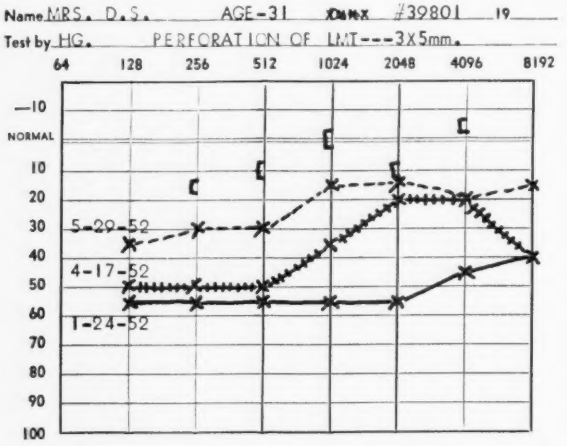

Fig. 7.—Audiograms, Case 3: Unbroken line, preoperative; crossbarred line, post fenestration, with traumatic perforation still present 10 weeks after surgery; broken line, after closure of 3 by 5 mm. perforation, in three treatments, showing hearing improved well into practical level.

Examination showed bilateral, inferior, kidney-shaped central perforations, each measuring 4 by 6 mm. The audiogram revealed a mild conduction loss in the right ear and a moderate conduction loss in the left ear, the hearing in both ears being appreciably improved by paper-patch prostheses. Subsequent closure of the perforation of the left tympanic membrane in 12 treatments and of the right tympanic membrane in 16 treatments, as recorded on Aug. 17 and

Oct. 26, respectively, resulted in much better hearing levels in both ears than those predicted as a result of the patch-prosthesis test (Fig. 8). The last recheck, on Feb. 19, 1951, revealed a normal tympanic membrane and a normal hearing level in both ears.

CASE 5.—M. L. S., a married woman aged 36, complained in July, 1951, of an intermittent right otorrhea present "all her life." A thorough history elicited the pattern of almost constant discharge following her first head cold in the fall and lasting until the following summer except when her winters had been spent in Florida or southern California. The fall head colds also usually initiated a persistent nasal blocking, postnasal discharge, and severe nightly coughing, which lasted until the following summer. Both the nasal and the aural symptoms failed to respond to repeated local treatment and various antibiotics. Repeated chest x-rays had given negative results. The first examination revealed a somewhat triangular, anterior-inferior central

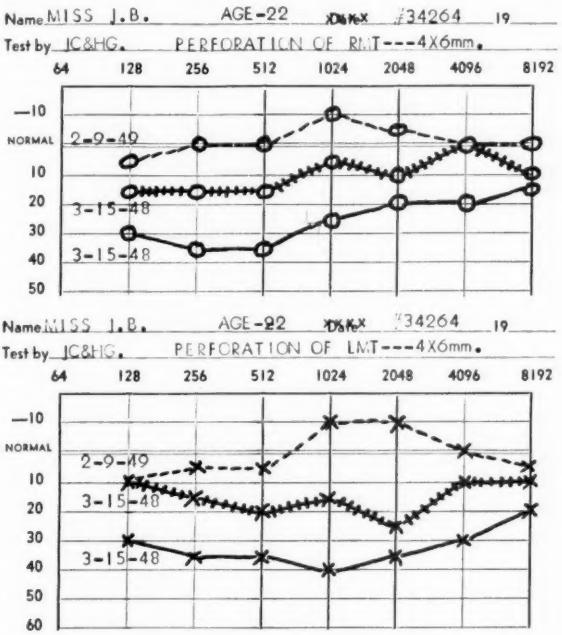

Fig. 8.—Audiograms, Case 4, in which both eardrums were perforated: top, right ear; bottom, left ear. Unbroken lines represent hearing with perforations present; crossbarred lines, hearing with paper patches covering both perforations; broken line with circles, hearing gain of 32 db. in right ear after closure in 16 treatments; broken line with *x*'s, hearing gain of 42 db. in left ear after closure in 12 treatments.

perforation, 3 by 3.5 mm. in size, in the right tympanic membrane. The left tympanic membrane was intact but contained a small anterior atrophic scar. The audiogram revealed a mild conduction hearing loss in the right ear. The nose was clear, and there was no evidence of adenoid or tonsil remnants.

Closure treatment was started in the hope of taking advantage of the patient's usual freedom from discharge during the summer. Little progress was made with either Euthymol or urea drops during the first nine treatments. In mid-October the usual fall head cold developed, and the usual nasal symptoms and cough appeared, along with a mucoid otorrhea in the right ear. This wintertime nasal and bronchial allergy, in my experience, was a much better indication of a house-dust sensitivity than was a borderline positive intradermal skin test. The allergic chronic otitis media responded immediately to house-dust desensitization, this being the first

time the otorrhea had ever been cleared up by treatment during the wintertime; the nasal and bronchial symptoms were only moderately relieved. Twenty-four subsequent closure treatments produced slow progress, in spite of scarification with the diamond curette, until June, 1952, when use of Euthymol instead of urea was resumed. Closure was obtained in eight more treatments. The audiogram showed an excellent hearing improvement (Fig. 9).

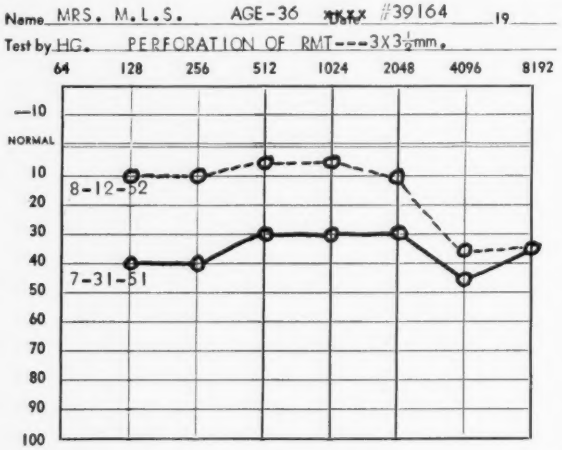

Fig. 9.—Audiograms, Case 5. Broken line represents hearing gain of 23 db. in right ear after successful control of allergic chronic otitis media followed by closure of 3 by 3.5 mm. perforation in 41 treatments.

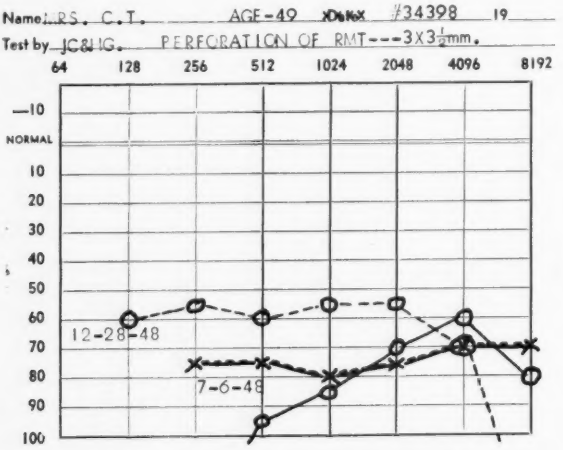

Fig. 10.—Audiograms, Case 6. Broken line with circles shows hearing gain in right ear of 26 db.; line with *x*'s, unchanged hearing in left ear. Hearing-aid performance was considerably improved by closure of perforation in right ear in 14 treatments.

CASE 6.—C. T., a married woman aged 49, complained in April, 1948, of a profound bilateral deafness. The loss in the right ear dated from childhood, and a perforation was known to be present. The loss in the left ear had occurred about four months previously, when the patient had first noted the onset of a whistling and bell-like tinnitus in that ear followed by "weak spells" and "dizziness." Hearing tests revealed a profound bilateral nerve deafness, with some

conductive loss in the right ear, which had a 3 by 3.5 mm. anterior-inferior central perforation. The history suggested a possible vascular accident to have been the cause of the sudden hearing loss in the left ear. The patient could not use a hearing aid satisfactorily in either ear. A patch prosthesis over the perforated right tympanic membrane gave appreciable improvement. Fourteen closure treatments at two-week intervals closed the perforation by Dec. 28. The patient then underwent a hearing-aid evaluation at the Northwestern University Medical School Hearing Clinic and could be fitted with the expectation of moderate practical benefit, although a discriminatory problem would probably persist. This result was not spectacular (Fig. 10) but nevertheless was much appreciated by the patient.

RESULTS

A total of 143 central perforations of the tympanic membrane have been treated by me in the past six years. In 131 cases treatment was carried through to either successful or unsuccessful conclusion. Of these, there was successful closure in 99, and 32 were counted as failures after a thorough trial of treatment. Of the 32 failures, in 3 cases treatment was discontinued because of an acquired sensitivity to the medications used and in 2 cases it was discontinued because of ultimate failure to control the allergic chronic suppurative otitis media, with its frequent recurrence of discharge.

There were four cases of discontinued treatments in which the trial was progressing well but was interrupted by the patient's moving to a distant community. In one of these the perforation later healed spontaneously. In four other cases treatments were discontinued at the request of the patient, who became discouraged, although the trial had been too short to reveal whether progress could be made or was occurring. Thus, eight patients were considered to have had an inadequate trial of treatment.

The percentage of successful repairs in all cases considered terminated after a complete trial was 75.6; if the cases in which treatments were discontinued after incomplete trials are included, the successful percentage is still 71.2.

There were nine cases of known recurrence of the perforation after successful closure, occurring from three months to three and one-half years later. Eight recurrent perforations have been successfully healed again, and one is showing a progressive closure under treatment. The percentage of recurrence was 9.1.

The 99 patients with healed perforations showed an average hearing gain of 16.3 db. in the speech range, the greatest gain recorded for any one patient being 42 db. (Fig. 8). Seven perforations were closed with no gain in hearing. Forty-one of the patients had more than the average decibel hearing gain, and 58 had less than the average.

The 99 successful closures were accomplished with an average of 14.6 treatments per case, the quickest closure occurring in 2 treatments and the longest in 64 treatments. Thirty-four patients exceeded the average in the number of treatments needed for closure, and 65 required less than the average number of treatments.

There are four perforations undergoing treatment at present.

SUMMARY AND CONCLUSIONS

The experience gained from the use of a modification of Linn's[20a] technic for closure of tympanic-membrane perforations in 143 ears enables me to offer a patient with a dry central perforation of the drum membrane, even though it is as large as 7 by 8 mm., at least 7 chances out of 10 for a successful repair of that perforation.

The healed perforation has approximately 1 chance in 10 of recurring, but the recurrence will heal with relatively few treatments.

The patient can expect a hearing improvement at least equal to and often appreciably better than the hearing level obtained by covering the perforation with a cigarette-paper prosthesis.

The technic I have followed results in closure in an average of about 15 treatments. This average, however, offers little help in trying to estimate for an individual patient the probable number of treatments that will be necessary for successful repair of his perforation. In this series there was no readily apparent correlation between the size of the perforation and the time of healing, nor did the size seem to influence the chances for eventual closure. No statistical correlation could be established between the age of the patient and the duration of treatment or the prognosis for closure.

The perforated drum membrane in patients with allergic chronic otitis media tended to have intercurrent discharge more frequently from an upset in allergic balance, and this frequently prolonged the treatments, but the relative percentage of success in allergic patients was about equal to that in nonallergic patients.

The reason for a difference in the character of the healing response of the tympanic membrane between individuals, or even between two eardrums with fairly symmetrical pathology in the same individual, was not established by my study.

LARYNGECTOMIZED SPEECH

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THE NEED for speech rehabilitation in laryngectomized persons has existed since 1873, when Billroth performed the first laryngectomy operation. For years the person who underwent this type of surgery found himself deprived of verbal communication. Today, the speech pathologist conducts preoperative and postoperative rehabilitation, integrating physiology and phonetics in the rehabilitative program.

The psychological trauma which is evident in patients who are not oriented preoperatively can be avoided. This emotional maladjustment is found in patients who upon awakening realize their inability to communicate verbally. Many of these patients not only require extensive postoperative consultation, but sometimes are in need of psychiatric aid. This situation can be avoided through preoperative consultation, with explanation of the speech mechanism and postoperative compensatory speech production.

The quality of laryngectomized speech depends on early training after operation. Occasionally a patient stumbles into an excellent method without formal training. However, formal instruction decreases the chance of development of defective speech habits and mannerisms associated with laryngectomized speech, or esophageal speech. Common defects found with poor instruction or lack of instruction are: (1) loud emission of air through the tracheal stoma while attempting speech; (2) unnecessary lip movement; (3) a tendency to revert to buccal, or whispered, speech; (4) audible efforts at swallowing; (5) superficial movements of the arms, body, and head, and (6) dyslalic speech.

The empirical method of retraining the laryngectomized person is to instruct him to swallow air into the stomach and emit it slowly and evenly, in order to produce a continuant belch sound. To facilitate the swallowing of air, many therapists give their patients carbonated water or sodium bicarbonate. I find this procedure unnecessary, and it may cause organic complications.

The purpose of this paper is to evaluate a therapeutic technique which will not conflict with the functional status of the organism. Before initiating a speech rehabilitative program for a laryngectomized patient, it is wise to evaluate the prospective procedure in terms of its effect. It is conceivable that not all persons can belch at will. The patient who is instructed to swallow air (into the esophagus) and belch may find difficulty in regurgitating the air; probably an air bubble is accumulating at this time in the stomach.

This method of retraining the laryngectomized person is being conducted in the Speech Clinic at the Presbyterian Hospital, Newark, N. J.

The rehabilitation of speech of the laryngectomized patient "ideally" should begin before surgery. This stage of rehabilitation involves: (1) explanation of the operation, the reason for the operation, and the effect of the operation upon the individual; (2) explanation of the use of laryngectomized speech as a therapeutic technique, with initial exercises, and (3) the answering of questions frankly.

After the operation speech therapy should begin as soon as medically feasible. Depending upon the healing of the patient, postoperative therapy can generally start within two to six weeks.

In the initial postoperative therapeutic session the role of the speech mechanism should be explained. The patient must understand the loss of verbal communication through this type of surgery as related to speech and body functioning, so that he can understand the therapeutic program. Understanding by the patient creates a progressively steadier acceleration of rehabilitation.

During the explanation of laryngectomized speech, the patient should be made to understand that the body process in speech is reversed in reference to breathing. During normal speech production a person exhales air as he speaks, but in laryngectomized speech he holds his breath.

A scale of advancement should be presented to the patient so that at all times he and the therapist understand their present status and know what the next step will be.

Since not every one can belch at will, and to avoid changing the organic relationships of the body by congesting the stomach with superfluous air, the following method should be used. Rather than have the patient swallow air into the esophagus and stomach as the primary location of the air for initial speech, the patient is instructed to constrict the pharyngeal muscles and the diaphragmatic muscles at the start of voluntary swallowing. With this method he will not swallow air into the esophagus.

Following are the five basic steps in the initial stage of learning laryngectomized speech:

1. The patient is instructed to take a normal inhalation of air.

2. After inhalation, the patient should hold his breath.

3. While holding his breath the patient should collect the accumulated air in the oral cavity and transfer it to the pharyngeal cavity (Fig. *A*, *B* and *C*). The bolus of air is then subjected to the initial stage of voluntary swallowing.

4. Immediately upon initiating voluntary swallowing, the patient is instructed to constrict the pharyngeal and diaphragmatic muscles (Fig. *D*). This constriction will produce a continuant sound.

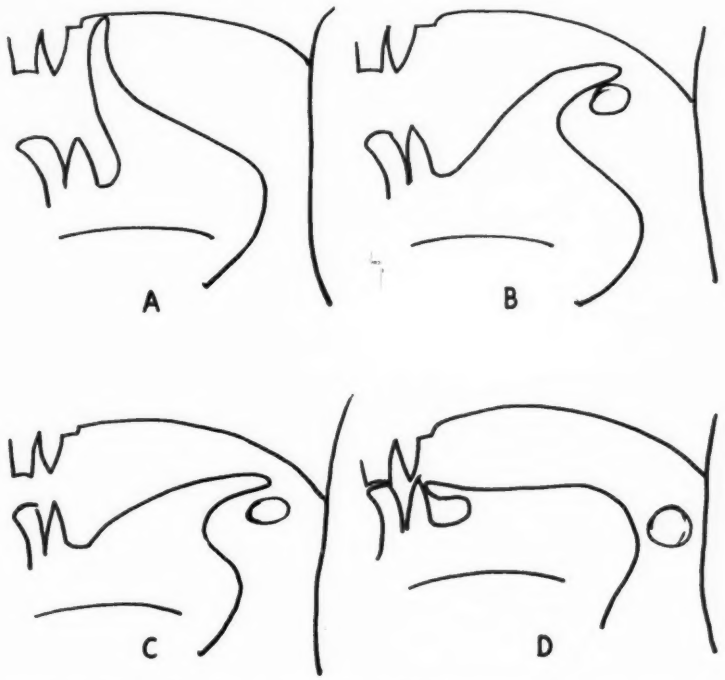
5. The patient is then instructed to exhale.

When the patient has control of the continuant sound, he should start to use words. If he initiates the usage of words by articulating monosyllabic words, control of extensive verbalization, satisfactory for fluent articulate speech, will develop.

The first words that a laryngectomized person should attempt are: bar, look, see, has, can, spot, once, day, how, are, and you. Besides these words the patient should attempt to say his name and address, plus the names of his immediate family. The ability to say his name is important psychologically. He feels greater security when he can pronounce his name rather than resort to a pencil and paper.

After the patient can pronounce the monosyllabic words he should proceed to the bisyllabic. While he is learning to say monosyllabic words he should also attempt simple sentences, using one word at a time.

The practice of having the patient count from 1 to 20 can be useful only in extending the number of syllables that can be uttered on one continuant sound. The practice of using the numerical progression will not buy the patient a loaf of bread or ask for directions. The patient who proudly demonstrates that he can count from one to a million does not interest me. He still cannot do anything if the house is on fire.



A, tongue tip to alveolar ridge; *B*, tongue tip as it glides toward pharyngeal wall; *C*, tongue tip at posterior area of palate just before voluntary swallowing; *D*, initial phase of voluntary swallowing, with immediate constriction of pharyngeal and diaphragmatic muscles.

The therapist working with laryngectomized patients should be careful to help them avoid mannerisms that are associated with such persons:

1. Lack of synchronization, or excessive lip movement, which develops when the patient listens for the sound before attempting speech.

2. Audible swallowing, which occurs when a patient is overconscious of his speech and tenses the pharyngeal muscles.

3. Audible clicking of teeth, which may be pronounced if the patient wears dentures.

4. Lack of volume, which occurs when the patient does not hold his breath through all the preparatory procedures.

5. Masking of the speech sound, which occurs when air escapes through the tracheal stoma.

CONCLUSIONS

Rehabilitative programs should start with preoperative consultation in which the patient is informed as to the effect of the operation on verbal communication and postoperative training is explained, so as to prevent psychological trauma.

The speech pathologist, who is trained in phonetics and physiology, should reeducate the laryngectomized person while working hand in hand with the surgeon. It is important to remember that the individual is a whole being composed of mind and body and should be treated as such.

Rehabilitative speech training for the laryngectomized person should consist of a detailed program of which the goal is fully understood by the therapist as well as the patient.

The use of carbonated water or sodium bicarbonate is a hindrance. Instead of being a helpful "crutch," it can endanger the patient by changing the organic relationships of the body. Another thing to remember is that the patient is not going to carry a bottle of carbonated water around with him.

IMPORTANCE OF BACTERIOLOGY IN EAR INFECTIONS

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INFECTIONS of the ear are usually classified as infections of the external ear, the middle ear, and the inner ear, in accordance with the scheme indicated in the following outline:

I. External otitis
- Acute
  - Circumscribed
  - Diffuse
- Chronic
  - Suppurative
  - Eczemotoid

II. Otitis media
- Acute
  - With effusion
  - Suppurative
  - Necrotic
- Chronic
  - Mucopurulent
  - Bone necrosis
  - Cholesteatoma

III. Inner-Ear infections, or labyrinthitis

We should like to classify these infections in a slightly different manner to emphasize the difference in bacteriological etiology. This etiology, in turn, has a great deal to do with the therapeutic approach to each individual problem.

Bacteriologically, ear infections can be classified as:

I. Infections arising via the Eutachian tubes
- A. Acute and chronic otitis media
- B. External otitis secondary to otitis media
- C Labrynthitis secondary to otitis media

Etiology: Streptococcus, Pneumococcus, Staphylococcus, and so on
Therapy: Penicillin, sulfonamides, aureomycin, oxytetracycline (Terramycin), chloramphenicol (chloromycetin), streptomycin (via blood stream)

Infections arising via the Eustachian tubes usually involve Gram-positive organisms, which are almost invariably susceptible to one of the several newer antibiotics in a concentration which is readily obtainable by the blood stream. These drugs have so revolutionized the therapy of this type of ear infection that surgical intervention (a simple complete mastoidectomy) is rarely needed.

II. Infections arising via the external auditory canal
- A. External otitis
- B. Infections of:
  1. Radical or modified-radical mastoidectomy cavity
  2. Fenestration cavity
  3. Cholesteatoma sac
- C. Acute and chronic otitis media infected via a perforated eardrum

In a sense these infections can all be called forms of external otitis. At one time they were considered fungus infections. However, work in the last few years by Senturia,[1] Hayes and Hall,[2] McLaurin,[3] Gill and Gill,[4] and others has shown them to be primarily bacterial infections.

Most investigators find roughly these percentages for the etiology of external otitis: bacteria, 75%; bacteria and fungi, 20%, and fungi, 5%. Gram-negative bacteria, and especially Pseudomonas aeruginosa, are the principal bacterial invaders. Our own statistics, from 81 cases, show the following invaders in 34 ears with acute diffuse external otitis:

	Severe	Moderate	Mild
Pseudomonas	8	11	2
Escherichia coli	—	2	—
Staphylococcus aureus	—	4	—
Staphylococcus albus	—	2	3
Nonhemolytic Streptococcus	—	2	—
Gram-positive rod	—	1	—
Fungi	—	—	—

Invaders in 47 ears with chronic diffuse external otitis were:

	Suppurative	Eczematoid
Pseudomonas	28	—
Proteus	2	—
Staph. aureus	3	2
Staph. albus	—	14
Micrococcus catarrhalis	—	1
Nonhemolytic Streptococcus	—	4
Fungi	—	—

Thus it appears that chonic suppurative and severe or moderately severe acute external otitis is almost always an infection due to Pseudomonas or at least to a Gram-negative organism. Also, Gram-negative organisms are almost the sole resistant etiological agents in this type of infection.

One of the most important locations for acquiring infections via the external ear canal is the swimming pool. The water is always contaminated with Gram-negative organisms, and in spite of ear plugs it invariably penetrates the external ear canal, any perforation in the tympanic membrane, and any crevice in a surgical cavity. In a well-regulated pool the requirement that swimmers take a complete soap and water shower before putting on swimming suits and after using the toilet, plus the use of adequately chlorinated water, can reduce this factor to a minimum. It should be mentioned that chlorine is effective only when the organic-matter content in the water is held to a low level, as in the continuous-filter and recirculation type of pool. The chlorine in pools which are too crowded or which are drained and refilled at intervals is rapidly inactivated by an accumulation of organic matter, and these pools do harbor infections.

In the therapy of these particular types of infection some of the drugs which are usually employed are: 2% methylrosaniline chloride (gentian violet); tincture of thimerosal (Merthiolate); merbromin (Mercurochrome); aluminum acetate

1. Senturia, B. H.: Etiology of External Otitis, Laryngoscope **55**:277 (June) 1945.

2. Hayes, M. B., and Hall, C. F.: Newer Concept of Management of Otogenic Infection, Arch. Otolaryng. **47**:289 (March) 1948.

3. McLaurin, J. W.: Use of Roentgen Rays in Small Dosages for Relief of Pain in Inflammations of External Ear, Laryngoscope **58**:317 (April) 1948.

4. Gill, W. D., and Gill, E. K.: Otitis Externa: Some Comments Concerning the Present Status of Therapy, South. M. J. **43**:428 (May) 1950.

(Burow's solution); sodium thiosulfate; acetic acid; Dalhyde; nitrofurazone (Furacin); Sulfamylon; coparaffinate (Iso-Par) ointment, and sulfanilamide ointment.

The use of these drugs is largely empirical. In our experience they have been effective against the milder infections but not against the severe ones, especially when Pseudomonas is encountered. The mercurial antiseptics in particular have been shown by Engley [5] and others to be less effective than previously thought and also to be inactive in the presence of organic matter such as that which would be present in external otitis. Some of the newer antibiotics are more useful.

In antibiotic therapy, penicillin and bacitracin (both of which are effective only against Gram-positive organism), streptomycin and polymyxin are bacteriocidal; aureomycin, chloramphenicol, oxytetracycline, and neomycin are bacteriostatic.

Some general observations which we have made are:

1. Penicillin and bacitracin are effective only against Gram-positive infections.

2. Polymyxin is effective only against Gram-negative infections.

3. Oxytetracycline is noneffective against many strains of Staphylococcus.

4. Penicillin is not effective against about 12% of the strains of Staphylococcus.

5. Bacitracin and neomycin should not be used systemically except to save life. Both are nephrotoxic. Neomycin is also highly neurotoxic to the acoustic nerve. In two patients of the University of Texas Medical School severe nerve deafness developed after systemic use of neomycin as a life-saving measure.

6. Polymyxin has been considered slightly toxic. It is probably safe in a dosage of 2.5 mg. per kilogram a day. Most patients, however, have a temperature of 100 to 102 F. and complain of burning at the site of injection during therapy with the drug. (The burning is materially helped by the use of 1:1,500 dibucaine [Nupercaine] with 1:50,000 epinephrine as a diluent).

7. Streptomycin should not be used alone against any infection, because organisms rapidly become resistant to it.

8. Bacillus coli and Alcaligenes infections are usually successfully treated by any of these drugs except penicillin and bacitracin.

9. Proteus vulgaris is usually resistant to all these drugs except streptomycin and occasionally polymyxin or chloramphenical.

10. Polymyxin is the drug of choice in Ps. aeruginosa infections. Oxytetracycline, neomycin, and, to a large extent, streptomycin, chloramphenicol, and aureomycin are also useful.

11. In most cases a culture of material from the ear is an important guide to effective therapy. Also, if P. vulgaris is present or if early therapy is ineffective, sensitivity tests are indicated, and it is well to have the organisms isolated and available.

12. The proper vehicle in local therapy is important. Medical vehicles are ointment, cream, ear drops (water base or glycol base), and dusting powder (used with an Upjohn blower).

5. Engley: Personal communication to the authors.

A. Senturia and Doubly [6] have shown that non-water-miscible vehicles inactivate the medication and prevent penetration.

B. We have found this observation correct and in addition find that oil bases macerate the skin.

C. Drops are useful in obtaining penetration of medication into inaccessible areas, as through perforation in the tympanic membrane. When the perforation is so small that medication will not gravitate into the middle ear, the displacement method can be employed to gain penetration through the perforation. Purulent discharge must first be removed by wiping or suction.

D. Aqueous drops tend to macerate the tissues. Glycerin or glycol is probably the preferable liquid base.

E. Where all areas are accessible, as in a radical mastoidectomy or fenestration cavity, use of dry powder has been the method of choice in our experience. It is best

*Pseudomonas Sensitivity (Twenty Strains)**

	Mg./Cc.			
	4	7	15	250
Polymyxin	95%	95%	95%	5%
Oxytetracycline	25%	50%	75%	15%
Neomycin	25%	44%	56%	0%
Streptomycin	10%	30%	40%	0%
Aureomycin	10%	....	15%	0%
Chloramphenicol	0%	0%	10%	30%
Bacitracin	0%	....	....	0%
Penicillin	0%	....	....	0%

* Sensitivity tests were done in a cooperative effort with Dr. Ellard M. Yow, of the Baylor University Department of Medicine. The tube dilution method was used. An additional 80 strains of Pseudomonas were studied by Dr. Yow, with results comparable to these.

and most economically applied with an Upjohn penicillin inhaler used as a powder blower. Its advantages are:

(1) There is stability of medication. (The aqueous solutions of chloramphenicol, oxytetracycline, and aureomycin must be discarded after 48 hours.)

(2) Concentration is high. (A saturated solution is obtained.)

(3) The distribution is not affected by gravity as it is in liquid medication.

(4) There is no maceration of the skin.

The disadvantages are:

(1) It cannot penetrate into pockets or into the middle ear via a perforation in the tympanic membrane as can liquid medication.

(2) It is occasionally irritating, especially to mucous membranes, where they are exposed.

As in applying any medication, it is important to cleanse the surface before the powder is applied.

6. Senturia, B. H., and Doubly, J. A.: Treatment of External Otitis: Use of Vehicles and Antibiotics in External Auditory Canal; in Vitro Studies, Laryngoscope **57**:633 (Oct.) 1947.

GENERAL PRINCIPLES OF THERAPY OF PARTICULAR TYPES OF EXTERNAL-EAR INFECTIONS

In attempting to apply these principles to specific infections, we shall describe the technique we use in combating the various conditions in which the organisms named are encountered.

External Otitis.—In the acute stage there is much swelling, and alleviation of pain is the primary consideration. This can be done with analgesics such as meperidine (Demerol) and codeine and by packing the canal with an aluminum acetate or *m*-creysylacetate wick, which also helps to reduce the swelling. In our experience, the use of systemic medication, even though apparently effective according to sensitivity tests, has not demonstrably affected the course of this disease or the duration of pain and swelling. Once the canal swelling has subsided so that medication can be dusted into the ear canal, oxytetracycline, neomycin, or polymyxin powder is used. The therapy is the same in chronic suppurative external otitis. With both conditions it is important to cleanse the canal adequately before applying the medication. An important point is adequate follow-up at decreasingly frequent intervals after the ear appears normal, with cleansing of the ear of wax and application of medication to prevent recurrence of the condition.

Chronic Otitis Media: Benign Type with a Central Perforation of the Tympanic Membrane.—Culture is important in therapy of this condition. The appropriate medication is used in the form of drops applied by the patient. If the perforation is small it may be necessary to use the displacement method, with the patient applying intermittent suction to the ear with the cup of his hand in order to cause the medication to enter the middle ear. Accessory therapy, such as investigation of allergy, removal or irradiation of adenoid tissue, clearing of sinus infections, and perhaps inflation of the Eustachian tubes, is helpful. Removal of polyps and granulation tissue is also important.

Suppuration Following a Radical or Modified Radical Mastoidectomy.—The cause of this condition has generally been considered poor surgical technique with inadequate removal of diseased tissue. For some time we have felt that, while this factor is important, one of the main causes of the frequent failure to obtain a dry ear after surgery is the presence of Gram-negative infection at the time of surgery. Most patients are routinely given penicillin before and after operation, and are treated postoperatively with sulfonamide powder, methylrosaniline chloride, and other medications which would be ineffective in Gram-negative infections.

In attempting to demonstrate this hypothesis, we reviewed 250 cases of radical and modified-radical mastoidectomy. Unfortunately, in only 15 of these 250 cases was material for culture taken preoperatively and in only 7 of these was it possible to ascertain the final result. Of the five patients who had Gram-positive infection before surgery, one still had a slight amount of moisture in the middle ear two years postoperatively. Of the two who had Gram-negative infections preoperatively, the ear of one was still draining one year after surgery. This study must be considered inconclusive.

Another approach to the problem is to obtain material for culture in all cases in which the ear continues to drain after a radical or modified-radical mastoidectomy. Twenty-one such cases have been tabulated, in 19 of which there was infection with a Gram-negative organism, usually shown to be Pseudomonas on culture. It was

possible to take over the management of 10 of these cases. The cavity was cleansed and dusted with specific antibiotic twice weekly. With this routine, 7 of the 10 ears became dry.

We feel that the following routine is important in obtaining a dry ear when a radical or modified-radical mastoidectomy or a revision of a mastoidectomy is to be performed:

Material for cultures are taken preoperatively, and often a sensitivity test is done. When the sensitivity is of such an order that a blood-stream antibody would be effective, therapy is started 24 hours before surgery so as to obtain a tissue saturation. The specific antibiotic is used also in the irrigating solution employed during the operation and postoperatively in the packing. After the packs are removed the cavity is dusted with the same antibiotic in the form of powder. The surgical technique and adequate removal of diseased tissue are also important. Frequently overlooked steps are adequate curettement and removal of hypotympanic tissue, tip, and zygomatic cells and removal of all the middle-ear mucosa in a radical mastoidectomy. It is also important, as Farrior [7] has emphasized, not to curette far down into the Eustachian tube but merely to curette the mouth of the tube and then place a skin graft over the orifice.

A check of a series of cases observed in the year and one-half since this study was begun, during which time specific-antibiotic therapy was applied in all cases of mastoidectomy, shows that 18 patients had a Gram-negative infection before surgery and that of these, one still had a draining ear one year postoperatively. Two patients had a Staphylococcus infection, demonstrated by culture of material from the ear, before surgery, and the ears of both of these patients are dry.

In the postoperative care of mastoidectomies and fenestrations it is important to prevent contamination of the wound with additional infection. Contamination frequently occurs from the patient's own fingers, from water which gets into the ear, and even perhaps from the physician himself, who may in his office have been attending patients with external otitis. Cotton used from office dispensers may have been contaminated by previous cases. We now make a definite rule that until epithelialization is complete the physician who is caring for the postoperative patient is to use a two-minute pHisoderm scrub, and the only applicators which are used in cleaning the ear are autoclaved for each case and placed in special fenestration packs. Fenestration packs also contain forceps for removing sutures, sterile scissors, and sterile cotton. The patient is given a sterile cotton picker and instructed to scrub three minutes each time before changing the cotton in his ear.

SUMMARY

Ear infections arising via the external ear canal frequently are due to bacterial flora resistant to the usual drugs. Newer antibacterial agents effective against these Gram-negative infections, plus more detailed bacterial study, give promise of decreasing the number of failures in the treatment of these conditions.

509 Hermann Professional Building.

7. Farrior, J. B.: The Radical Mastoidectomy: Anatomical Considerations in Surgical Technique, Surg., Gynec. & Obst. **89**:328 (Sept.) 1949.

CONGENITAL ATRESIA OF POSTERIOR NARES

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IN THE past few years a number of rather complete articles and reports have appeared in the literature on this subject. In order to conserve space I am purposely omitting a bibliography and instead refer the reader to a rather complete list found in a report of McGovern [1] and in an article by Sheehan and Swanker.[2] The purpose of this article is to report three cases previously not published, one a follow-up after 24 years.

As to the factor of heredity, Stewart,[3] in 1931, reported on bilateral atresia in sisters; an infant brother died of asphyxiation, probably due to the same cause. Wilkerson [4] cited Lang as reporting a boy, his sister, mother, possibly a brother, and maternal aunt, with bilateral atresia. Wilkerson himself reported complete bilateral bony atresia in three sisters. McGovern,[1] in 1950, reported occlusion in a mother and her child. Cabaniss, of Roanoke, Va., reported atresia in a mother and her twins.

In regard to statistics, the first case was described in 1829 by Otto, who had discovered the atresia at autopsy. As well as I can figure from scanning the literature, in the 123 years since that time, only 284 cases, including the 3 cases reported herewith, have been recorded.

The Royal Infirmary of Edinburgh, Scotland, reported only six cases in the 19 years from 1907 to 1926. The Massachusetts Eye and Ear Infirmary reported 10 cases in 16 years, 1922 to 1938. The Mayo Clinic recorded only 12 cases in 36 years, 1903 to 1939.

The condition is more frequent in the female (my three patients were females). It has been reported that 90% of the cases are osseous; 10%, membranous. Others have reported cases with a fair per cent of the mixed type. The majority, two-thirds or more, are unilateral.

As to the embryological cause, three theories have been advanced: (1) failure of the membrane to rupture and, thus, the persistence of the bucconasal membrane,

1. McGovern, F. H.: Congenital Choanal Atresia, Laryngoscope **60**:815-831, 1950.

2. Sheehan, J. E., and Swanker, W. A.: Surgical Repair of Congenital Choanal Atresia, Laryngoscope **59**:1320-1327, 1949.

3. Stewart, J. P.: Congenital Atresia of the Posterior Nares, Arch. Otolaryng. **13**:570-583, 1931.

4. Wilkerson, W. W., Jr., and Cayce, L. F.: Congenital Choanal Occlusion, Tr. Am. Acad. Ophth. **52**:234-246, 1948.

(2) persistence of the buccopharyngeal membrane (these membranes should rupture very early in the fetal life, about the sixth week or earlier), and (3) medial outgrowth of the vertical and horizontal processes of the palate bone. One might visualize a combination of two or all three of these conditions.

A review of the anatomy reveals the bony boundaries of the normal choana are (1) medially, the posterior border of the vomer and the nasal crest of the palate bone; (2) above, the ala of the vomer and the body of the sphenoid bone; (3) laterally, the medial plate of the pterygoid process of the sphenoid bone along with the perpendicular plate of the palate bone, and (4) inferiorly, the horizontal plate of the palate bone.

DIAGNOSIS

It is conceivable that asphyxiation and death in the newborn infant in many instances have been due to a bilateral occlusion of the choanae unrecognized and undiagnosed, and it is hoped that this article will help in warning obstetricians to be on the look-out for this dangerous complication. Practically all infants breathe entirely through their noses. If the nose of a sleeping infant is held forcibly closed, he will persist with extreme physical effort to breathe through it. Finally, he will awaken and gasp for breath instead of opening his mouth and breathing. This inherent tendency might well be the cause of the asphyxiation of many newborn and young infants. Choanal atresia may be suspected if the infant has repeated attacks of cyanosis and suffocation which are definitely relieved by crying and markedly aggravated by nursing or sleeping.

Failure of a probe to pass into the nasopharynx and a possible digital examination of the nasopharynx will serve in making a positive diagnosis. In the older child and adult, in addition to the above methods, iodized oil U. S. P. (Lipiodol) may be instilled into the nose and an x-ray plate may be made in order to show stasis and retention of the opaque solution. Sinusitis is rarely found, but there is always a greater or less quantity of glistening, heavy mucus lying on the floor of the nose. Removal of this by suction, shrinkage of the turbinates, and actual inspection may be sufficient for diagnosis. In the majority of patients, the cilia, the turbinates, the mucous membrane (except for a certain off-color appearance), and the sinuses have continued to develop normally. Seldom is the hearing greatly affected. McGovern states that out of 47 patients with atresia, all but 10 had essentially normal hearing. It is usually reported that the tympanic membrane is slightly thickened, dull or retracted.

TREATMENT

In the surgical correction of atresia, several methods of approach have been advocated and the procedures carried out successfully. The majority have been done anteriorly or intranasally. Morgenstern used surgical diathermy. Some physicians have used the transseptal method. Some employed the transantral method, and, lastly, the transpalatine approach was followed by Blair, Steinzeug, Schweckendiek, Neto, Ruddy, Owens, and others. Owens,[5] of Los Angeles, reported seven patients operated on successfully by the transpalatine approach. He feels that this route is

5. Owens, H.: Observations in Treating 7 Cases of Choanal Atresia by Transpalatine Approach, Laryngoscope **61**:304-319, 1951.

the one of choice for the infant and young child and that the operative procedure is logical and fairly simple. His youngest patient was 6 months, and the oldest was 21 years; they received the same operative procedure.

In the hands of a careful surgeon any of the above-mentioned methods will bring a greater or less degree of success. However, if the physician encounters a patient with choanal occlusion in his practice and contemplates surgery, I strongly urge that he consult the bibliography referred to and carefully study the surgical procedures described in the articles. Any surgeon can make an opening but his obligation lies in making an adequate one that will not later close up.

The arguments favoring the transpalatine approach are that (1) the operation is performed under direct, open vision, (2) permanency of the window is made possible by the removal of the posterior border of the septum, and the chances of success are further enhanced by removing the base, the adjacent hard palate, and (3) a flap of membrane is preserved and manipulated to cover the raw surface.

REPORT OF CASES

CASE 1.—Martha D. was seen in consultation on Dec. 28, 1928, at the age of 9 days. The infant was unable to breathe through her nose, and day and night the presence of either a nurse or a member of the family was required to occasionally force open her mouth to keep up the baby's breathing. Nursing was difficult and quite inadequate.

On examination, both nares were completely stopped up with mucopurulent secretion. This secretion was sucked out, and it was found that a probe would not enter the nasopharynx. The obstruction was rigid, proving that the occlusion was bony rather than membranous. When the baby's mouth was held closed, she would become cyanotic and not a sign of air would come through either side of her nose. An operation was advised, and on Feb. 1, 1929, at the age of 6 weeks, the child was taken to the hospital, a general anesthetic was administered, and the left side of the nose was operated on. A hand burr was used to make a small opening which was enlarged with bone-biting forceps. The baby stood the anesthetic well and began to breathe normally through this one side of her nose. A Malecot antrum wing catheter was inserted through the opening into the nasopharynx. For four weeks this tube was removed, cleaned, and replaced every other day. On April 19, when the baby was 4 months old, the right side of her nose was operated on and the window on the left was enlarged. During this operation the posterior border of the septum was partially removed with a burr and a forward-cutting bone forceps. The intranasal procedure is not easy and must be done largely by the sense of touch. Two wing catheters were inserted and for three weeks were removed and replaced every other day.

When the child was 5 years old, her large tonsils and adenoids were removed, and on digital examination the openings, though not large, were found to be patent and adequate.

Having developed normally, the patient is now 24 years old, is a graduate of the University of Louisville, and is happily married. Both posterior nares are still functioning normally.

CASE 2.—Norma Jean J., age 6, was seen in August, 1937. After the patient was carefully examined, she was found to have complete bony occlusion of the left posterior nares. No previous diagnosis had been made. The child otherwise seemed to be healthy and perfectly normal in every respect. The intranasal operation was performed on Sept. 20, 1937, with the patient under general anesthesia. Burrs and bone-cutting forceps were used as in the previous case. A Malecot wing catheter was inserted, removed, cleaned, and reintroduced every other day for two weeks. In June, 1938, while the patient was under local anesthesia, the opening was slightly enlarged in an office procedure.

This patient is now 21 years old, is married, and her posterior nares are still patent.

In operating on both of these patients, definite care was taken to carry the opening down into the floor of the nose, into the palate bone, and also to break down and to remove a good percentage of the posterior border of the septum. This was probably the reason for the success of the operations and for the openings remaining patent.

CASE 3.—Mrs. Dennis R., aged 37, was seen on June 21, 1945. Examination showed complete bony occlusion of the right posterior nares. In spite of her discomfort, the patient had not previously had her condition diagnosed. An operation was advised, but the patient refused to give her consent. She has never returned to my office but was seen on July 29, 1952, by one of my colleagues, Dr. Gordon L. Green. It seems that she still refuses to consent to an operation.

SUMMARY

The fact can be emphasized that the intranasal approach, though successful, is not too satisfactory in that it requires a great deal of time and after-care on the part of the surgeon and brings considerable discomfort to the patient. Possibly the transpalatine procedure will be the operation of choice in the future.

Case Reports

TERATOMA OF THE LARYNX

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AND
M. STUART STRONG, M.D., F.R.C.S. (England)
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TERATOMAS have been described by Willis [1] in his recent monograph as true tumors or neoplasms composed of multiple tissues foreign to the part in which they arise. Most teratomas occur in relation to the sacral region, the sex glands, or the neck, although there is scarcely a location in which they have not been found.

Willis subscribes to Krafka's [2] "organizer theory" of the origin of teratomas; he believes that teratomas represent areas of tissue which, during early embryonic development, escaped the action of the primary organizer, the notochord, and were allowed to develop and differentiate in a chaotic manner.

Many cases of teratomas of the neck have been reported in the literature; most of these were associated with the thyroid gland [3] and were discovered at or soon after birth. Chapman [4] reported a case of teratoma of the neck in a newborn infant, in which the tumor was attached to the hyoid bone, the larynx, and the trachea in the midline.

While large benign tumors of the larynx are not rare, the occurrence of a teratoma of the extrinsic larynx in an adult is of sufficient interest to warrant the following report.

REPORT OF A CASE

The patient was a 50-year-old white man, who presented the chief complaint of hoarseness and increasing difficulty in breathing for 10 years. The dyspnea became severe only during exertion and had not limited his activities. He had had no dysphagia. He had always been a heavy cigarette smoker, using about 40 cigarettes per day for 40 years.

Routine ear, nose, and throat examination revealed normal findings except in the larynx. Mirror examination showed a gross distortion of the normal anatomy; the right pyriform

Professor of Otolaryngology, Boston University School of Medicine, and Chief of Service, Massachusetts Memorial Hospitals (Dr. Johnson), and Instructor in Otolaryngology, Boston University School of Medicine, and Associate Visiting Surgeon, Massachusetts Memorial Hospitals (Dr. Strong).

1. Willis, R. A.: Atlas of Tumor Pathology: Section 3, Fascicle 9, Teratomas, Washington, D. C., Armed Forces Institute of Pathology, 1951.

2. Krafka, J., Jr.: Teratoma: Explanation of Its Cause Based on Organizer Theory of Embryology, Arch. Path. **21**:756-764, 1936.

3. Sutton, P. W., and Gibbs, E. W.: Congenital Teratoma of the Thyroid, Am. J. Surg. **63**:405-407, 1944. Munro, E. H., and Waldapfel, R.: Congenital Teratoma of the Thyroid, ibid. **64**:271-275, 1944. Bale, G. F.: Teratoma of the Neck in the Region of the Thyroid Gland: Review of Literature and Report of 4 Cases, Am. J. Path. **26**:565-578, 1950.

4. Chapman, F. D.: Teratoma of the Neck in the Newborn: Report of Case with Autopsy, Arch. Path. **32**:217-221, 1941.

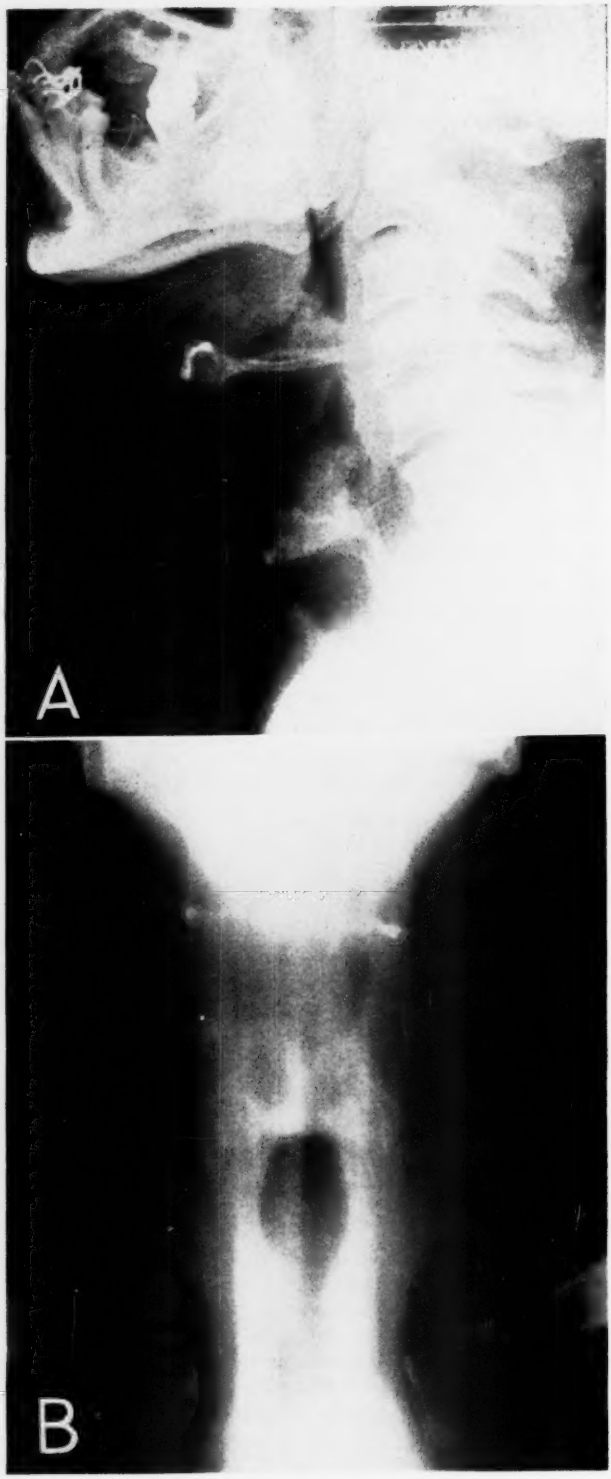

Fig. 1.—*A*, soft-tissue x-ray of the neck showing obliteration of the air column and calcification above the level of the hyoid bone. *B*, anteroposterior laminagram of the larynx showing lateral displacement of the right wing of the thyroid cartilage and upward displacement of the right greater cornu of the hyoid bone.

Fig. 2.—Gross specimen of teratoma.

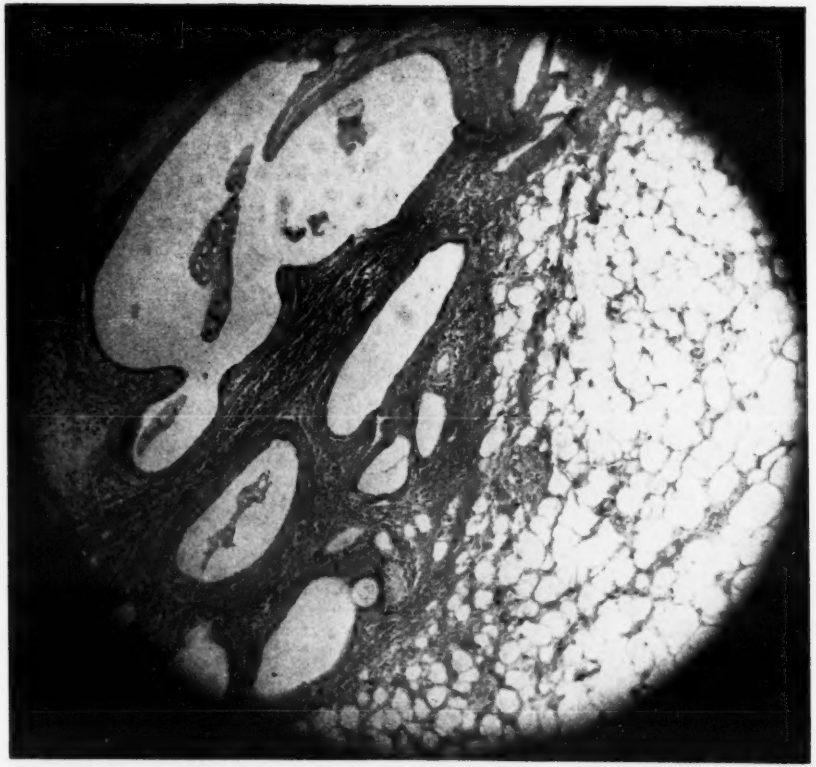

Fig. 3.—Low-power view showing fat cells and fibrous tissue glandular elements; × 90.

sinus was obliterated by a smooth swelling which encroached upon the right false cord and aryepiglottic fold. The epiglottis was displaced to the left so that it was not possible to see more of the interior of the larynx than the posterior two-thirds of the left vocal cord, which appeared to be normal. The right arytenoid cartilage was immobile. All visible portions of the laryngeal mucosa appeared normal. The mass felt firm and elastic when palpated through the mouth. No masses were palpable in the neck.

Soft-tissue x-rays of the neck (Fig. 1 *A*) revealed a mass in the upper part of the larynx which partially obliterated the air column and presented areas of calcification. Laminagrams

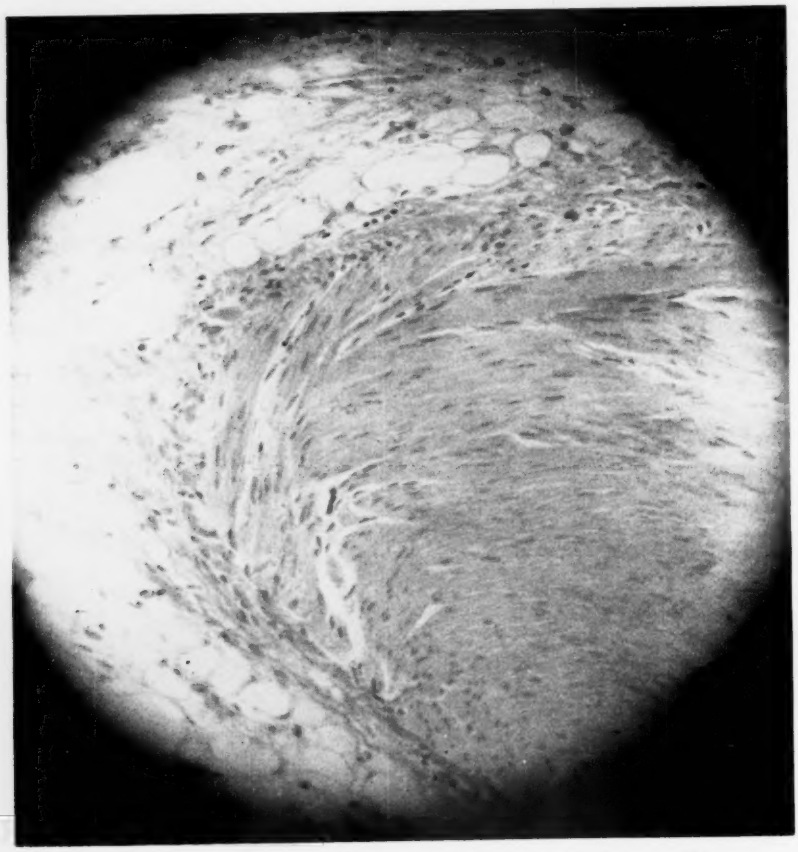

Fig. 4.—High-power view showing smooth muscle bundles; × 170.

(Fig. 1 *B*) outlined a mass which in the anteroposterior view showed lateral displacement of the right wing of the thyroid cartilage and upward displacement of the right greater cornu of the hyoid bone.

It was evident that this tumor of the extrinsic larynx was probably benign; consequently a differential diagnosis of lipoma, neurofibroma, ectopic thyroid tissue, and a tumor of branchiogenic origin was entertained.

The size of the tumor was such that there was no alternative to external operation; an elective tracheotomy was done to facilitate anesthesia. The soft tissues were reflected from the anterior surface of the thyroid cartilage, which was then divided in the midline. The

interior of the larynx was inspected, and the mucosa, including that of the true cords, was seen to be intact. The right true and false cords were, however, displaced medially so that the lumen of the larynx was greatly reduced. A firm elastic mass was palpable, lateral to the false cord, in the right pyriform sinus. The right thyrohyoid membrane was divided so that the right wing of the thyroid cartilage could be retracted laterally. This maneuver exposed the tumor very adequately so that it was possible to free it from the surrounding tissues by blunt dissection. A small pedicle which attached the tumor to the ventricle of the

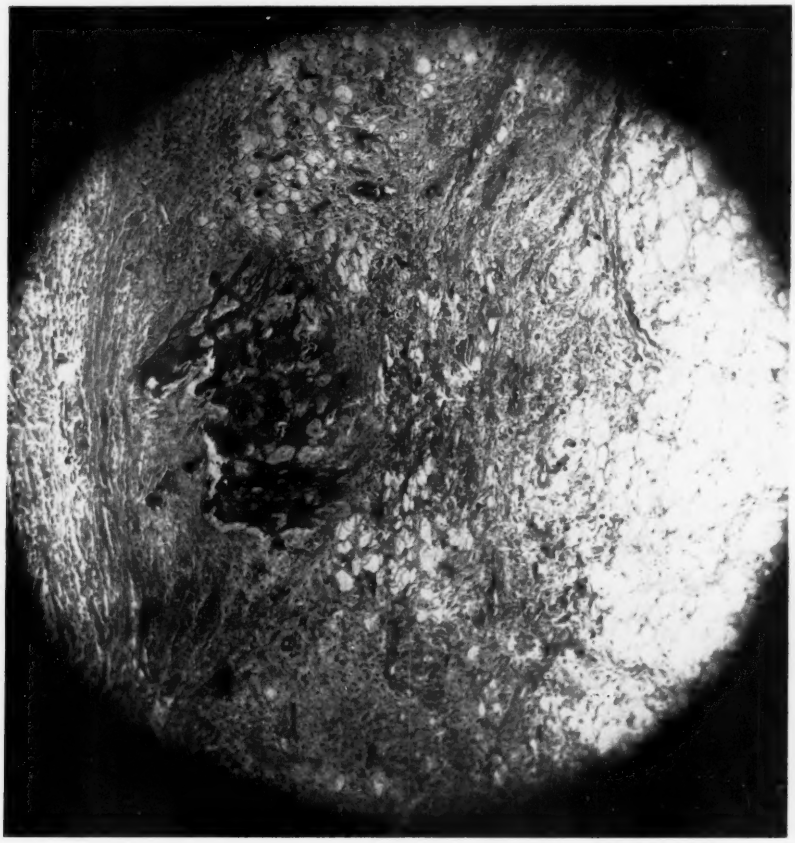

Fig. 5.—Low-power view showing osteoid tissue; × 90.

larynx was divided. The tumor was removed in toto without causing any further damage to the laryngeal mucosa. The larynx was closed in the usual manner.

The patient made an uneventful recovery, apart from an inflammatory reaction around the margins of the tracheal stoma; the tracheotomy tube was removed on the 10th day. On the 21st day, examination of the larynx showed that it had returned to within normal limits; the airway was free, and the voice was adequate.

The pathologist's report was of the greatest interest. Grossly the tumor had the appearance of a fibrolipoma (Fig. 2); it was golden yellow in color, irregularly

lobulated, and of a firm elastic consistency. Microscopically the tumor was composed mainly of fat cells, with a liberal admixture of fibrous tissue; scattered throughout the main stroma were numerous islands of glandular tissue in which the cyst-like spaces and ducts were lined with columnar epithelium (Fig. 3). Elsewhere there were areas of smooth muscle bundles (Fig. 4) and a few areas of osteoid tissue (Fig. 5). There was no evidence of malignancy. From the overall picture Dr. Rudolf Osgood concluded that the tumor was definitely of embryonal origin and should be classified as a teratoma of the larynx.

COMMENT

Benign tumors of the larynx are sometimes allowed to grow to an astonishing size before advice is sought; their rate of growth is so slow that the patient is able to tolerate the gradual increase of dysphagia and dyspnea for many years.

Most cases involve the region of the aryepiglottic fold primarily [5] and then extend laterally into the pyriform sinus and medially beneath the false cord.

Every effort should be made to locate the tumor accurately and to appreciate its exact extent and relations by using all possible diagnostic aids. Soft-tissue x-rays should always be made, and these will be of particular assistance when there is calcification in the tumor; laminagrams [6] will give contributory information. Another maneuver, which was not employed in this case, is the use of fluoroscopy and barium sulfate; the radiopaque material may be made to outline the margins of the tumor in the hypopharynx clearly.[7]

It is never possible to make the pathological diagnosis by clinical inspection alone, with the possible exception of an angioma; consequently the following tumors, which have been observed and recorded in the literature, must be included in the differential diagnosis: lipoma, fibroma, neurofibroma, chondroma, myoma, thyroid tumor,[8] angioma, and tumors of embryonal origin. Usually the tumor was found to be well covered by mucosa so that biopsy gave at best equivocal results; the diagnosis could not be established until the whole lesion had been removed and examined.

One tumor reported in the literature [9] slightly resembled the lesion reported here in that it appeared to be of branchial origin; the variety of tissues present, however, was much less.

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5. Palmer, A., and Mehler, L.: Recurrent Lipoma-Myxochondroma-Fibroma of the Larynx: Case Exhibiting Unique Features, Laryngoscope **46**:653-669, 1936. Smith, T. T.: Solitary Neurofibroma of the Larynx, Arch. Otolaryng. **39**:144-151, 1944. Neivert, H., and Royer, L.: Leiomyoma of the Larynx, ibid. **44**:214-218, 1946.

6. Layera, J.; Mascias, F. P., and Bertres, C.: Laryngeal Tomography as Indispensable Complement for Complete Localization of Tumors: Fundamental Principles of the Method, Semana méd. **2**:1428-1435, 1942. Ryan, M. D., and Zizmor, J.: Chondroma of the Larynx: Report of Case, Am. J. Roentgenol **62**:715-717, 1949.

7. Hoover, W. B.: Benign Tumors of the Larynx: Their Diagnosis and Treatment, S. Clin. North America **20**:697-719, 1940.

8. Beeson, H. B.: Aberrant Goiter with Report of Instance of Intralaryngeal Thyroid Tumor, Arch. Otolaryng. **25**:449-454, 1937.

9. Imperatori, C. J.: Branchiogenetic Cyst of the Larynx Removed by Thyrotomy, Laryngoscope **39**:679-683, 1929.

Large tumors of the extrinsic larynx can only rarely be removed through the mouth, and then only when the lesion is well pedunculated. External operation with an elective tracheotomy is usually necessary; the approach used will be suggested by the location of the tumor. Most commonly, laryngofissure, with or without division of the thyrohyoid membrane, has been used. Lateral pharyngotomy,[7] in which the tumor is approached from behind after division of the attachment of the inferior constrictor to the thyroid cartilage, may be sometimes more practicable. Occasionally the transhyoid route[10] may facilitate the exposure.

A satisfactory return of laryngeal function can be anticipated following removal of large benign tumors of the type discussed; providing no malignant tendencies are found, a permanent cure can be expected.

SUMMARY

A benign teratoma of the extrinsic larynx is described.

The differential diagnosis and treatment of similar benign tumors is discussed.

10. Harbert, F.: Lipoma of the Larynx, Ann. Otol. Rhin. & Laryng. **60**:982-985, 1951.

FIBROSARCOMA OF THE LARYNX

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FIBROSARCOMA of the larynx probably represents less than 1% of the total malignant neoplasms in this area. Lymph node metastases are rare, though there is usually local invasion of the perilymphatics.

Figi,[1] in 1933 reported two cases of sarcoma and two cases of fibrosarcoma. Rigby and Holinger,[2] in 1943, reported a case of fibrosarcoma in an infant with a fatal outcome. Tucker,[3] in 1935, found only one case of sarcoma. Miller,[4] in 1950, reported fibrosarcoma in a 6-year-old child, in whom a total laryngectomy appeared to have eradicated growth of the tumor. Lachman[5] reported from Israel one case of fibrosarcoma and one of lymphosarcoma, both without recurrence after laryngofissure in one and hemilaryngectomy in the other. Sirota and Hurwitz[6] most recently (September, 1952) reported a chondrosarcoma of the larynx in a 62-year-old man, apparently arrested after a total laryngectomy.

The following case is reported as an addition to those cited:

W. K., a 68-year-old retired watchman, was first seen on Jan. 4, 1951, with a chief complaint of intermittent hoarseness of one year's duration. In the previous three months he had become increasingly dyspneic, with his voice just a whisper and his coughing constant. He said that there had been no weight loss, dysphagia, or pain. He complained of nasal obstruction of many years' duration, and said that more recently his hearing had become "blocked" easily.

His past history revealed a severe mouth infection at the age of 20, which was treated many times by cautery, resulting in a perforation of his hard palate, for which he had worn a dental prosthesis.

Examination revealed an alert but very dyspneic elderly man, cooperative and not apprehensive. His nose showed a badly deflected dorsum externally and a nearly occluding deflection of the septum. The hard palate had a 3 cm. defect extending into the soft palate. Both Eustachian orifices were blocked, but blocking was relieved by catheterization. The epiglottis was rotated 45 degrees counterclockwise. Both false and true cords were freely movable, but a large, smooth, glistening tumor could be seen subglottically attached to the anterior commissure. There were no palpable cervical nodes. He was admitted to the hospital for tracheotomy, laryngoscopy, and biopsy. The direct view substantiated the indirect picture. The tissue was extremely rubbery, and several attempts were made before an adequate biopsy specimen could be taken. Microscopic examination of the tissue showed intertwining whorls of fibers with spindle-shaped nuclei, with hyperchromatic and mitotic figures.

1. Figi, F. A.: Sarcoma of the Larynx, Arch. Otolaryng. **18**:21-33 (July) 1933.

2. Rigby, R. G., and Holinger, P. H.: Fibrosarcoma of the Larynx in an Infant, Arch. Otolaryng. **37**:425-427 (March) 1943.

3. Tucker, G.: Cancer of the Larynx: Observation in 200 Consecutive Cases, Arch. Otolaryng. **21**:1-8 (Jan.) 1935.

4. Miller, D.: Fibrosarcoma of the Larynx: Report of Case in a Child, Ann. Otol. Rhin. & Laryng. **59**:246-253 (March) 1950.

5. Lachman, J.: Sarcoma of the Larynx, A. M. A. Arch. Otolaryng. **53**:299-307 (March) 1951.

6. Sirota, H. H., and Hurwitz, A.: Chondrosarcoma of the Larynx, A. M. A. Arch. Otolaryng. **56**:290-293 (Sept.) 1952.

A Kline test, complete blood count, and urinalysis gave negative results. The blood sugar and nonprotein nitrogen were within normal limits. An electrocardiogram and x-rays of the chest showed nothing abnormal.

Because the patient refused a total laryngectomy, a laryngofissure was carried out on Jan. 30 with the patient under intravenous thiopental sodium anesthesia. The mucosa was split to left of mid-line, revealing a well-demarcated tumor involving the anterior one-third of the right cord and anterior commissure. A subperichondrial dissection was carried out, the inner surface of the anterior wall of the cricoid being denuded. No extension of the tumor could be discovered grossly. He made an uneventful recovery, and the cannula was removed on Feb. 12.

Weekly follow-up visits revealed an adequate airway, a fairly good voice, and no evidence of recurrence until March 12. At this time there was some blood-streaked sputum and a small smooth mass could be seen in the anterior commissure. Two weeks later there was a palpable mass overlying the thyroid cartilage. He was therefore hospitalized, another tracheotomy was performed, and a biopsy specimen was removed by direct laryngoscopy. Recurrence of tumor was reported, and the patient underwent a total laryngectomy on May 8. At operation a 4 cm., round, rubbery, firm mass was found attached to the thyroid cartilage and extending into the larynx. A total laryngectomy was carried out, the epiglottis and hyoid bone being included, down to the first tracheal ring. The impinging strap muscles were excised, although they showed no gross involvement. After a second uneventful convalescence, the patient was discharged from the hospital on May 26, eating well and with a well-healed and well-functioning tracheal stoma. The pathological report from the laryngectomy showed microscopic extension into the strap muscles at this time.

He gained 10 lb. (4.5 kg.) in the next month, but in July he began to have localized masses in his neck above the stoma. Then, although the response to x-ray was expected to be nil, he was given 6,000 r over a period of two months. This resulted in no abeyance of the growth, but only in central necrosis of the tumor mass.

He was hospitalized for terminal care and died quietly in his sleep on Oct. 13. At autopsy, the original diagnosis was confirmed, with the additional findings of metastases to the soft tissues of the neck and both lung fields.

SUMMARY

A case of fibrosarcoma in a 68-year-old man is reported. Although he eventually died of the disease in spite of a total laryngectomy, it is felt that had this procedure been carried out originally, his chances of survival would have been enhanced.

Clinical Notes, New Instruments and Techniques

GEAR-POWER DETACHABLE LARYNGOSCOPE HOLDER AND SIMPLIFIED POSITION FOR DIRECT LARYNGOSCOPY

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The purpose of this article is to describe an instrument and a simplified system, which I have found repeatedly workable, of positioning the head for direct laryngoscopy. This method requires only three stacked sheets, which are placed under the patient's back and extended to the top edge of the shoulder. The patient's head is placed so that the vertex is resting on the operating table. This procedure dispenses with head holders, either mechanical or human.

With this method I have used a detachable laryngoscope holder, which is attached to the handle of the standard Jackson laryngoscope. The instrument incorporates some of the characteristics of the laryngoscopes developed by Seiffert, Roberts, and Andrews, and of the

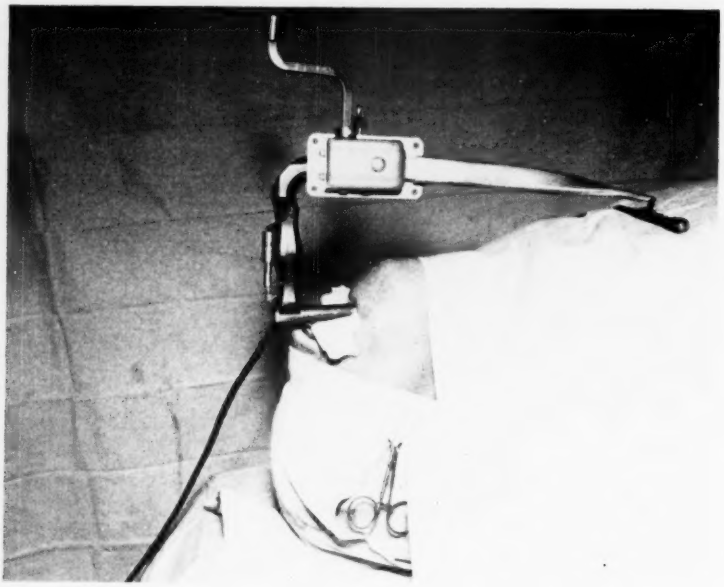

Fig. 1.—Patient with instrument in position (no head holder).

Andrews' instrument modified by Somers. Exposure of the anterior commissure is easily accomplished by hand-power driving through the worm. The sprocket gear lifts the laryngoscope tip to the desired position.

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The instrument was manufactured by V. Mueller Co., Chicago.

The Lynch spatula and mouth-opening attachment to the laryngoscope holder mentioned in the article is now being completed. The attachment will dispense with overhead gallows.

Fig. 2.—Detachable leverage laryngoscope holder.

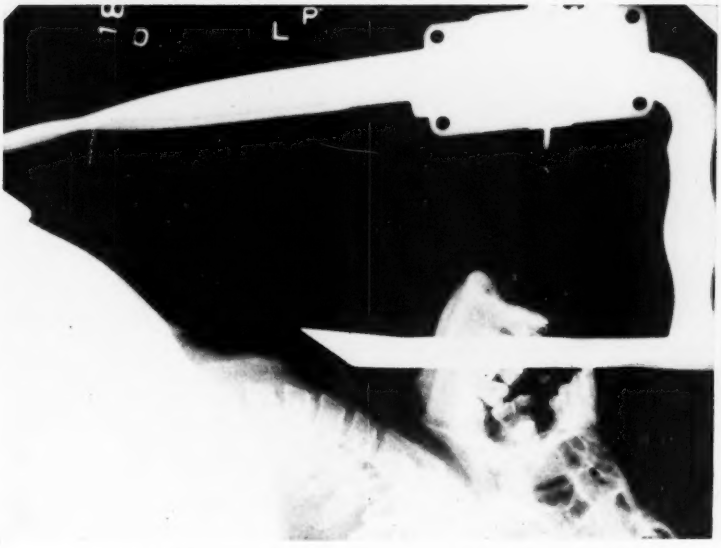

Fig. 3.—Head extended with laryngoscope in position (X-ray).

AN OPERATING-ROOM LIGHT FOR ENDOSCOPY

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AND
HELEN CARRESE, R.N.
ROCHESTER, N. Y.

The problem of lighting the instrument table during bronchoscopy and esophagoscopy has vexed nearly all endoscopists at one time or another. While some operators do not mind extraneous light, there are a great many to whom extraneous light is more of a hazard than just a nuisance. With the coming of age of thoracic surgery and the resulting refinements in bronchoscopic technique, a constant lighting factor becomes more important than heretofore. Especially

Fig. 1.—Light attached to metal wall plate. While table top and instruments are adequately lighted, there is little spread of illumination about room.

important is the constant lighting factor in the judgment of color changes in the tracheobronchial mucous membranes of the tuberculous patient under specific drug therapy for whom surgery is pending.

With these factors in mind, a special operating-room light for the endoscopist has been designed and is herein presented. It has several features which make it desirable. The light source is a small 15-watt yellow bulb which gives sufficient light to make visible the top of the instrument table, yet the shade prevents spread around the room. The light is of a "soft" quality; thus, there is a minimum of reflection from the metal instruments on the table. Further, light of this quality does not interfere with the accommodation of the operator (Fig. 1). While

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the light was first designed for bronchoscopic work, it is obvious that the factors mentioned make it equally valuable in any endoscopic procedure, such as cystoscopy, proctoscopy, and peritoneoscopy.

THE LIGHT[1]

The long aluminum shade and grill are so designed as to give a satisfactory illumination of the average instrument table free of shadows and at the same time limit the spread of light about the room. The 15-watt yellow bulb is placed deep within the barrel of the shade. This apparatus is in turn attached to a universal joint, so that the light can be turned or tilted as desired (Fig. 2).

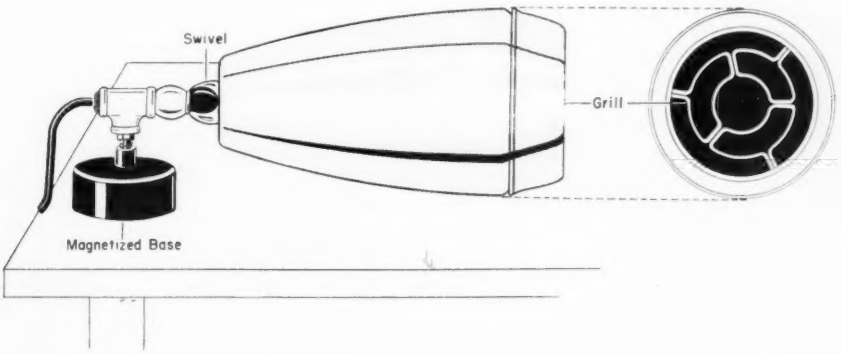

Fig. 2.—Schematic drawing of light showing major points of interest in its construction.

The base of the lamp is unique in that it is magnetic and thus may be transferred from one metal top table to another without the mechanical inconvenience of detachment, or it can be placed on a Mayo stand if the operator wants the light above the instrument table. The magnet is strong enough to hold the light to a metal wall plate, which can be placed at any desired level if the set-up of the operating room is more or less permanent.

SUMMARY

1. An endoscopic operating room light has been described.

2. It has been found satisfactory for the purpose for which it was designed, i. e., to provide a constant source of illumination for the instrument table which will not disturb the operator's powers of accommodation and will enhance his ability to judge the color changes seen in endoscopic examination.

1. The Emerson-Carrese Endoscopic Operating Room Light is available to members of the medical profession through Knebel-Electro-Optical Instruments, 317 Rhinecliff Drive, Rochester 18, N. Y. It can be obtained with either common or shock-proof electrical connections.

Progress in Otolaryngology

Summaries of the Bibliographic Material Available in the Field of Otolargyngology for 1952

BRONCHOESOPHAGOLOGY

F. J. PUTNEY, M.D.
J. J. O'KEEFE, M.D.
L. W. McSTRAVOG, M.D.
AND
W. H. BALTZEL, M.D.
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THE BRONCHIAL cartilages extended for approximately 10 generations along axial pathways and were found by Hayward and Reid [1] to give support to the proximal half of these generations. Since many of the proximal intrapulmonary bronchi are visible bronchoscopically, it has repeatedly been confirmed by bronchoscopy that the lumen is never obliterated except by severe local processes which damage the wall, such as inflammatory or neoplastic strictures or pressure of diseased lymph nodes. The extent of the bronchial cartilage was found to be normal in cylindrical bronchiectasis, suffered the greatest reduction in saccular bronchiectasis, and was reduced variable degrees in the various intermediate forms of bronchiectasis. Cartilage was scarcely ever found in the walls of bronchiectatic saccules. In bronchiectasis associated with massive collapse, only the bronchi normally supplied with circumferential cartilage remained patent. Because of this it was thought that in massive collapse all the bronchi without circumferential support and all the bronchioles collapsed with the alveoli and that it was the circumferential support of the cartilage in the proximal bronchi that kept them open.

Hayward and Reid [2] described their observations on the anatomy of the intrasegmental bronchial tree and divided it into a proximal bronchial part, in which cartilage is present, and a distal bronchiolar part, from which cartilage is absent. In addition to this distinction the bronchi were found to narrow progressively and to have irregularly spaced branches of two types: (1) acute-angled divisions with a carina and (2), less frequently, wide-angled divisions without a carina. The bronchioles taper only slightly and branch at regular intervals, with all divisions being similar. These branches have no carina and appear as small, circular holes in the side-wall of the axial bronchiole. Within any segment several axial pathways were recognized. These fan out from the apex to the most distal surface of the lung, forming a framework for the lung. Shorter, lateral pathways arise from these and supply the more proximal parts of the segment. From the bronchial part, which extends for about two-thirds of the length of an axial pathway, branches arise. The remaining portion of the bronchial tree is bronchiolar, and from this part 10 to 15 branches arise.

1. Hayward, J. N., and Reid, L. M.: The Cartilage of the Intrapulmonary Bronchi in Normal Lungs, in Bronchiectasis, and in Massive Collapse, Thorax **7**:98 (March) 1952.

2. Hayward, J. N., and Reid, L. M.: Observations on the Anatomy of the Intrasegmental Bronchial Tree, Thorax **7**:89 (March) 1952.

An intrabronchial caliper for obtaining measurements of the bronchial lumen was described by Emerson.[3] This instrument was devised to allow the endoscopist to obtain measurements in the main bronchi with a minimum of trauma to tissue. The instrument was thought to be particularly applicable to measurements of the size of the lumen in partially stenotic bronchi, which may prove helpful to the thoracic surgeon. The instrument is an adaptation of a Riba urethrotome, with a dial on the handle to give the size of the lumen directly in the French scale. The instrument is passed through the bronchoscope to the depth indicated and the handle turned to cause a bulge in the silver wire at the distal end of the instrument. When the expansion of the wire has become maximum the reading can be made directly from the dial.

HISTOLOGY

The basic principles of ciliary structure were studied with the electron microscope by Engström and Wersäll.[4] Vibratile cilia of several protozoa, sauroids, and mammals had a striking structural similarity. Often there was a basal body with at least one minute rootlet and a vibratile portion above this body. The vibratile part consisted of a central fibrillar core surrounded by a fragile, sometimes helical sheath. The fibrillar central part commonly comprised about 11 fibrils running the whole length of the cilium. The fibrils were of uniform caliber, and their general arrangement and number resembled the structure of the spermatozoan tail.

A study to determine the effects of menthol, nicotine, and the smoke of mentholated and nonmentholated cigarettes on excised mammalian respiratory epithelium from humans, rats, and rabbits was undertaken by Rakieten and others.[5] No difference between the effects of smoke solutions from mentholated and from nonmentholated cigarettes on the ciliated respiratory epithelium was found.

A study of the normal histology of the lower esophagus was made by Strauss and Lubitz,[6] with special reference to the glandular structures. Seventy-two cardioesophageal junctions of successive autopsy specimens were examined. Three types of glandular structures were found: the cardiac glands, the esophageal glands, and an occasional island of true gastric mucosa. Discrete nests of cardiac glands opening into the esophagus were found in many of the specimens, and submucous collections of mucinous esophageal glands with many dilated and cystic ducts were also seen. Only one specimen exhibited true gastric mucosa in the lower esophagus. Sufficient acid-forming cells to produce acid enough to account for ulceration in the esophagus were not found. If acid is the cause of esophageal ulceration, it must come from gastric regurgitation. The breaks in the stratified epithelium caused by the openings of the glandular ducts may be the source of entrance for infection or irritating acid.

3. Emerson, E. B., Jr.: Intrabronchial Caliper, A. M. A. Arch. Otolaryng. **55**:724 (June) 1952.

4. Engström, H., and Wersäll, J.: Some Principles in the Structure of Vibratile Cilia, Ann. Otol. Rhin. & Laryng. **61**:1027 (Dec.) 1952.

5. Rakieten, N.; Rakieten, M. L.; Feldman, D., and Boykin, M. J.: Mammalian Ciliated Respiratory Epithelium: Studies with Particular Reference to Effects of Menthol, Nicotine, and Smoke of Mentholated and Non-Mentholated Cigarettes, A. M. A. Arch. Otolaryng. **56**:494 (Nov.) 1952.

6. Strauss, G. D., and Lubitz, J. M.: The Cardioesophageal Junction: A Histologic Study, Laryngoscope **62**:359 (April) 1952.

PATHOLOGY

Mayer and Rappaport [7] presented a highly theoretical concept of the origin of cystic lungs, bronchiectasis, and emphysema when they attributed these lesions to postnatal developmental defects. In this scheme of origin it was postulated that bronchiectasis was at one end of the evolution and emphysema at the other. The links between them were given as cystic bronchiectasis and cystic emphysema.

The effects of metaplasia of bronchial epithelium, elevated endobronchial pressure, and nasopharyngeal instillation of bacteria were studied in young, healthy rats singly and in various combinations by O'Neill and his associates.[8] Metaplasia and keratinization of the bronchial epithelium was produced by the use of a vitamin A deficient diet. Although various degrees of pulmonary emphysema were produced, along with a few instances of bronchitis and lung abscesses, there were no histologic changes in the lungs of any of the animals to suggest bronchiectasis. The absence of bronchiectasis in this study lends support to the theory that complete or partial bronchial obstruction probably plus infection is necessary for the production of bronchiectasis.

PHYSIOLOGY

A new method for observing bronchial movements and elasticity by means of a bronchial caliper was described by Andrews.[9] A bronchial caliper was developed which has expanding blades under variable spring tension and which records by means of an electrocardiographic machine tracings indicating the diameter and movements of the bronchi. Accuracy was placed within ± 1 mm. in determining motion, and the technique and speed of manipulation enable it to be used as a routine phase of the usual bronchoscopy. By this method expression of elasticity of the bronchial walls was made by application of the physical principles of elasticity. Tracings collected from 11 patients were presented, indicating normal and abnormal readings. Although the development of the apparatus has not been perfected, it offers hope for providing additional information concerning the physiology of the bronchial tree.

After roentgenologic investigation of the cricopharyngeal muscle, Brunner [10] concluded that the two portions of the inferior constrictor muscle responded in different manners when the pressure in the hypopharynx was increased during Valsalva's experiment. The pressure produced distention of the oblique portion of the muscle, while the circular portion responded with a spastic contraction, forming what was called the hypopharyngeal bar. The spastic contraction of the cricopharyngeal muscle was dependent upon both the pressure in the hypopharynx and the excitability of the cricopharyngeal musculature. Unilateral recurrent laryngeal nerve paralysis did not interfere with the contractability of the cricopharyngeal muscle but in some cases caused hypoexcitability of the muscle. In functional disorders there

7. Mayer, E., and Rappaport, I.: Developmental Origin of Cystic, Bronchiectatic and Emphysematous Changes in the Lungs: A New Concept, Dis. Chest **21**:146 (Feb.) 1952.

8. O'Neill, J. F.; Bradshaw, H. H.; Hightower, F., and Ward, D. E., Jr.: Effects of Increased Endobronchial Pressure, Vitamin A Deficiency Diets and Nasopharyngeal Instillations of Bacteria on Tracheobronchial Trees of Young Rats, J. Thoracic Surg. **24**:80 (July) 1952.

9. Andrews, A. H., Jr.: Observations on Bronchial Movements and Elasticity by Means of a Recording Bronchial Caliper, Ann. Otol. Rhin. & Laryng. **61**:1181 (Dec.) 1952.

10. Brunner, H.: Cricopharyngeal Muscle Under Normal and Pathological Conditions, A. M. A. Arch. Otolaryng. **56**:616 (Dec.) 1952.

was observed hyperexcitability of the cricopharyngeal muscle associated with moderate and periodical dysphagia. The finding of a permanent hypopharyngeal bar in carcinoma of the hypopharynx was thought to indicate that the tumor had not involved the cricopharyngeal sphincter. In two cases of injury to the neck hopoexcitability of the cricopharyngeal muscle was reported.

BRONCHOSPIROMETRY

Gaensler and Cugell [11] reported the methods and results obtained by bronchospirometry, ambient air bronchospirometry followed by conventional oxygen breathing being used. The relative oxygen uptake of the two lungs remained unchanged in the normal person. Twelve patients with moderate unilateral pulmonary functional impairment revealed no difference of relative oxygen uptake of the involved lung on changing from room air to oxygen breathing. Seven patients had severe unilateral pulmonary insufficiency, and the mean oxygen uptake of the affected side was 3% of the total on room-air breathing and 12% of the total on oxygen breathing.

Adequate information concerning the differential functional participation of each lung was obtained in 94% of bronchospirometrical procedures by Gaensler and Watson.[12] Ulcerative tracheobronchial tuberculosis and hemoptysis within two weeks were used as absolute contraindications to bronchospirometry. Obstruction of the main bronchus and far-advanced pulmonary tuberculosis were relative contraindications. Dyspnea and pulmonary insufficiency were not considered contraindications. Febrile reactions and spreads were more common in patients with far-advanced unstable disease and in toxic patients with severe symptoms. Early recovery of the cough reflex and removal of secretions were facilitated by avoiding postoperative sedation and by postural drainage. Among the 107 patients in whom topical anesthesia was induced with a cocaine base solution, there were no toxic reactions, but in 40% of the asthmatics an allergic response developed. Of the 753 patients who received tetracaine, 0.3% had a mild toxic reaction and 44% of the asthmatics had an allergic reaction in the form of an acute attack. Of the patients with tuberculosis, a greater percentage exhibited a febrile reaction and extension of the disease as shown by roentgenogram after the use of cocaine solution than after tetracaine.

Comparative bronchospirometric and angiopneumographic studies were made by Rimini and his associates [13] on 24 patients with pathologic lesions affecting only one lung. There was a correlation between the results of the two methods, and angiopneumographic study might replace bronchospirometry in the majority of cases. When both the respiratory and the circulatory functions of abnormal lungs are reduced, angiopneumography appears capable of determining the function of the various segments of each lung.

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11. Gaensler, E. A., and Cugell, D. W.: Bronchospirometry: IV. Ambient-Air and Oxygen-Recording Bronchospirometry, J. Lab. & Clin. Med. **40**:410 (Sept.) 1952.

12. Gaensler, E. A., and Watson, T. R., Jr.: Bronchospirometry: III. Complications, Contraindications, Technique and Interpretation, J. Lab. & Clin. Med. **40**:223 (Aug.) 1952.

13. Rimini, R.; Rodriquez, A.; Burgos, R.; Duomarco, J.; Sapriza, J., and Surraco, G. H.: Contribution of Angiopneumography to Some Problems of Pulmonary Physiopathology, Dis. Chest **22**:539 (Nov.) 1952.

ANESTHESIA

The method of preparation of patients for peroral endoscopy as used at the Mayo Clinic was outlined by Olsen and Pender.[14] The preparation was begun with the psychological approach, and the nature of the examination and its purpose were discussed with the patient. The cooperation of the patient is essential and hospitalization is desirable but not always necessary. For sedation in bronchoscopy the average patient was given 1½ grains of pentobarbital sodium about one hour prior to the examination and morphine sulfate subcutaneously, 1/6 grain, and atropine sulfate, 1/150 grain, when called to the endoscopy room. For anesthesia 12 grains of crystalline cocaine hydrochloride was dissolved in 4 cc. of distilled water immediately before needed, thus making a fresh 20% solution of cocaine. The patient was seated in a low chair opposite the physician, who applied the cocaine solution to each pyriform sinus and the larynx by means of Jackson cross-action laryngeal forceps. Then 2 cc. of fresh 5% cocaine solution was instilled between the vocal cords into the trachea by means of a syringe and laryngeal cannula. By positioning of the patient the solution was made to enter both sides of the bronchial tree. General anesthesia was rarely used for bronchoscopic examinations. For esophagoscopy the premedication was similar to that for bronchoscopy, but the barbiturate was usually administered by rectum rather than by mouth. A 20% solution of cocaine was applied to the pyriform sinuses, but no intratracheal instillation was used. In practically all cases light general anesthesia was combined with topical anesthesia. Administration of small doses of thiopental sodium intravenously, with or without curare, was advocated in most instances, but these small doses were adequate only if teamwork existed between the esophagoscopist and the anesthesiologist. In bronchoscopic and esophagoscopic examinations of children the type of anesthesia employed depends on the age of the child and the type of the procedure. For most older children the routine procedure as outlined for adults can be followed. For the newborn infant or young child general anesthesia was avoided whenever possible. At times a small dose of secobarbital (Seconal) sodium or pentobarbital sodium was given by rectum. The anesthetic agent of choice for the infant or small child was tribromoethanol solution administered rectally, the dosage varying from 90 to 100 mg. per kilogram of body weight. When bronchography was planned ether anesthesia was preferred. Reactions caused by the use of cocaine were found extremely infrequently, and the reactions resulted from overdosage of the drug rather than from specific sensitivity to cocaine.

In summarizing the problem of topical anesthesia in bronchoscopy, Rubin and Kully [15] emphasized that the three basic considerations in establishing a safe technique are controlled total dosage, preliminary testing for sensitivity, and slow fractional instillation. Experimentally cocaine and tetracaine were found to be two to four times more toxic when applied to the tracheobronchial tree than when injected subcutaneously. Since the prime consideration in establishing safety is controlled dosage, the amount of anesthetic agent should be calculated in milligrams

14. Olsen, A. M., and Pender, J. W.: Preparation of Patients for Peroral Endoscopy, J. A. M. A. **150**:842 (Nov. 1) 1952.

15. Rubin, H. J., and Kully, B. M.: Topical Anesthesia in Bronchoscopy, A. M. A. Arch. Otolaryng. **56**:13 (July) 1952.

and limited to the amount falling within safety levels. The necessity for careful measurement of the total dose administered and restriction to that amount was emphasized. Patients should be tested preliminarily for hypersensitivity by the application of a small measured amount of the anesthetic agent to the oral or pharyngeal mucous membrane. This rule should apply also to those patients who have undergone the topical anesthesia in the past without untoward effect, for in the interval decreased tolerance to the drug may have developed. Slow fractional instillation and avoidance of large amounts at one time was found to keep blood levels from reaching dangerous peaks. Other factors, such as choice of drug, concentration, and the use of epinephrine, are matters of technique and can be varied to suit the need of the individual endoscopist.

Three basic agents were used by Rumble and his co-workers [16] to obtain anesthesia for peroral endoscopic procedures. Cocaine, thiopental (Pentothal), and ether were the primary agents. In the adult cocaine hydrochloride (10%) in 3 to 8 cc. amounts was applied topically to the pharynx and larynx, and this was followed by sufficient thiopental with or without curare to produce narcosis. Premedication was accomplished with a barbiturate and opiate. For patients with a tendency toward bronchospasm meperidine (Demerol) was substituted for morphine and aminophylline and procaine were given intravenously. In cases of acute status asthmaticus or severe emphysema and for children under 12 years of age, ether anesthesia was employed. To young children a barbiturate and to older children an opiate was given as sedative. Cocaine hydrochloride, 4%, in amounts not exceeding 0.5 cc. was used for topical application in children. The mortality rate was 0.1% for all types of risks for the more than 5,000 patients submitted to this type of anesthesia.

Carabelli [17] recommended tetracaine (Pontocaine) hydrochloride in 0.25% solution as a safe, effective and long-lasting surface anesthetic agent suitable for bronchoscopy and bronchography.

CONGENITAL ANOMALIES

A series of 185 cases of congenital malformations of the trachea, bronchi, and lungs was presented by Holinger and his associates.[18] Among the total hospital admissions during a 15-year period, 0.002% of the patients were found to have anomalies of the lower respiratory tract exclusive of the larynx. With the growing interest and improved techniques of bronchoscopy and thoracic surgery for the newborn, the need for a more accurate knowledge of the normal variations as well as the malformations becomes apparent. The diagnosis of congenital malformations of the lower respiratory tract during life is made through the teamwork of the pediatrician, roentgenologist, bronchologist, and thoracic surgeon. The history of obstetrical trauma or subsequent chest injury must be born in mind. From the physical findings one may differentiate a laryngeal anomaly from other obstructions

16. Rumble, L. R., Jr.; Gude, A. V., and Galvin, W. H.: Anesthesia in Peroral Endoscopy, J. M. A. Georgia **41**:480 (Nov.) 1952.

17. Carabelli, A. A.: The Use of Pontocaine in Subposologic Quantities for Bronchoscopy and Bronchography, Anesthesiology **13**:169 (March) 1952.

18. Holinger, P. H.; Johnson, K. C.; Parchet, V. N., and Zimmerman, A. A.: Congenital Malformations of the Trachea, Bronchi and Lung, Ann. Otol. Rhin. & Laryng. **61**:1159 (Dec.) 1952.

to respiration by the character of the cry and by the use of direct laryngoscopy. Differentiation between an obstructive emphysema of one lung and an atelectasis of the opposite lung may depend entirely upon physical examination of the chest. A frequent erroneous interpretation was noted in the case of infants admitted to the hospital with a single chest film, the report indicating atelectasis of the relatively uninvolved lung rather than the more significant obstructive emphysema of the opposite side. Additional information can be obtained by fluoroscopic study, inspiration and expiration films, lateral views of the neck, study of the barium-swallowing function, bronchography, planography, and angiocardiography. Bronchoscopy was used without anesthesia for diagnosis of unusual respiratory conditions in infants. Safety in this procedure was maintained by limitation of the duration of the procedure, the use of small instruments, and the administration of oxygen during the examination. Exploratory thoracotomy in infants increased the scope of diagnosis. In this review of anomalies of the lower respiratory tract a frequent association of anomalies of other organs and systems as well as a frequent multiplicity of anomalies within the respiratory tract itself was encountered.

Cotton, Spaulding, and Penido [19] reported a case of an accessory lung complete with three lobes arising from a main bronchus, which gave directly off the trachea. This occurred in a 2-month-old infant who was examined because of a persistent cough. Bronchographic studies revealed saccular bronchiectasis in the accessory lung. When operation was performed it was found that this lung had its own pleural cavity and was completely separated from the other right lung, which appeared grossly normal but contained only two lobes.

Putney and Baltzell [20] reported a case of agenesis of the lung with tracheal stenosis in an infant. There were flattening of the left thorax, scoliosis to the left, and loud, coarse râles throughout the left lung. Roentgen and fluoroscopic examinations disclosed no aeration of the left lung, with a rudimentary sixth rib on the left side. On bronchoscopic examination the larynx was seen to be somewhat smaller than normal, and the trachea was narrowed in its anteroposterior diameter. No left bronchus was visualized. A bronchogram revealed normal bifurcation of the trachea, but only a portion of the left main bronchus was outlined, the remaining portion being absent.

A case of esophagobronchial fistula in an adult which was thought to be congenital was reported by Berman, Test, and McArt.[21] The chief symptom was persistent cough, which had been present since childhood. It was not until the patient was 40 years old that the diagnosis was made. The fistula extended from the esophagus into the basal subdivisions of the left lower lobe bronchus, and at operation associated vascular anomalies were discovered.

A rare case of atresia of the cervical esophagus in a 12-year-old girl from a fibromuscular stenosis of the cricopharyngeus muscle was reported by Johnson and

19. Cotton, B. H.; Spaulding, K., and Penido, J. R. F.: An Accessory Lung: Report of a Case, J. Thoracic Surg. **23**:508 (May) 1952.

20. Putney, F. J., and Baltzell, W. H.: Agenesis of the Lung with Tracheal Stenosis: Case Report, Ann. Otol. Rhin. & Laryng. **61**:677 (Sept.) 1952.

21. Berman, J. K.; Test, P. S., and McArt, B. A.: Congenital Esophagobronchial Fistula in an Adult, J. Thoracic Surg. **24**:493 (Nov.) 1952.

Mangiardi.[22] The cause of the stenosis was thought to be either a congenital atresia of the esophagus or a post-tonsillectomy retropharyngeal abscess. While congenital atresia was suggested by the intact and normal mucosa and the lack of paraesophageal fibrosis, the more likely explanation indicated by the clinical course was a low-grade infection of the retropharyngeal area following tonsillectomy with the development of fibrosis in the pharyngeal muscles and resulting contraction of the cricopharyngeal musculature. Distortion of the left pyriform sinus, which was also present, would favor the latter view.

A case of an infant having esophageal atresia coexistent with tracheoesophageal fistula and other anomalies was recorded by McGarity and his associates.[23] Significance was attached to the physical sign of a loud to-and-fro rush of air within the stomach at each respiration.

In the diagnosis of high congenital tracheoesophageal fistulae in infants, DeCarlo and his co-workers [24] found iodized oil roentgenoscopy to be of limited value because of the possibility of an erroneous diagnosis due to aspiration of the radiopaque solution. In 13% of the newborn infants studied iodized oil was aspirated when the material was swallowed. Aspiration probably resulted from neuromuscular immaturity and the low surface tension of the iodized oil.

King and Walker [25] warned of the dangers involved in using radiopaque material to establish the diagnosis of congenital esophageal atresia and esophagotracheal fistula. Very small amounts of iodized oil were used when the diagnosis could not be established by inserting a small catheter into the upper esophageal segment.

Robb [26] reported on a patient with a history of cough, choking, and episodes of cyanosis since birth, who lived until 11 years of age before a tracheoesophageal fistula without atresia but with a large esophageal diverticulum was discovered. After an operation in which the fistula was closed and the diverticulum reduced, the patient was relieved of symptoms.

BRONCHOSCOPY AND CHEST SURGERY

In a symposium on the relationship of bronchoscopy to chest surgery Kergin [27a] expressed the viewpoint of the thoracic surgeon. It was felt that the bronchoscopist, who can check his findings against what he sees and feels through the open chest and what he finds on studying the excised specimen, can become more expert in the

22. Johnson, E. K., and Mangiardi, J. L.: Atresia of Cervical Esophagus, J. Thoracic Surg. **24**:75 (July) 1952.

23. McGarity, W. C.; Abbott, O. A., and Grove, L. W.: Congenital Atresia of the Esophagus with Tracheoesophageal Fistula, Duodenal Atresia, and Other Anomalies: A Case Report, Ann. Surg. **135**:566 (April) 1952.

24. DeCarlo, J., Jr.; Tramer, A., and Stratzman, H. H., Jr.: Iodized Oil Aspiration in the Newborn, A. M. A. Am. J. Dis. Child. **84**:442 (Oct.) 1952.

25. King, R., and Walker, J. S.: Congenital Atresia of the Esophagus and Esophagotracheal Fistula, J. M. A. Georgia **41**:545 (Dec. 12) 1952.

26. Robb, D.: Tracheoesophageal Fistula Without Atresia But With Large Esophageal Diverticulum, Australian & New Zealand J. Surg. **22**:120 (Nov. 2) 1952.

27. (*a*) Kergin, F. G.: The Relationship of Bronchoscopy to Chest Surgery: Symposium, Laryngoscope **62**:765 (Aug.) 1952. (*b*) Jackson C. L.: The Relationship of Bronchoscopy to Chest Surgery: Symposium, Laryngoscope **62**:772 (Aug.) 1952. (*c*) Broyles, E. N.: The Relationship of Bronchoscopy to Chest Surgery: Symposium, Laryngoscope **62**:784 (Aug.) 1952.

interpretation of what he observes through the bronchoscope. In contrast, many thoracic surgeons have too many other duties to permit them to acquire the necessary skill, so that bronchoscopy should be centralized in a relatively small number of competent specialists. It is important that bronchoscopists think beyond the bronchus and keep up their knowledge of diseases of the lungs as a whole, by frequent conferences with physicians, radiologists, and thoracic surgeons, and follow their cases through to a final pathologic diagnosis. In the case of bronchogenic carcinoma, the information obtained by bronchoscopy relates first to diagnosis and second to operability. In the case of bronchial adenomata, local treatment can be carried out when the pathologic report says the tumor is benign, there is no evidence of metastasis, and the bronchi distal to the tumor have not sustained irreparable damage. With respect to lung abscess and bronchiectasis, bronchoscopy is needed to rule out bronchial obstruction as a cause and to aid in localization of the source of the pus. In regard to tuberculosis it is necessary to know whether any of the major bronchi are involved before any form of surgical treatment is undertaken, and repeated bronchoscopic examinations are essential to follow healing during antibiotic therapy. The thoracic surgeon leans heavily on bronchoscopic therapy in postoperative atelectasis, and the bronchoscope is used to inflate the lung or irrigate the bronchial tree with antibiotics.

Jackson [27b] compared bronchoscopy in its relation to thoracic surgery with cystoscopy in its relation to genitourinary surgery. In both fields roentgen and endoscopic study are indispensable. Improved drainage of suppurative lesions, preoperative and postoperative treatment, and palliative treatment of inoperable conditions can be accomplished by bronchoscopic means. When obstruction is present, whether due to foreign body, inflammatory stenosis, or tumor, it can often be removed by endoscopic means, and it can almost always be accurately diagnosed. The bronchoscopist acts as an assistant to the internist and the thoracic surgeon except in cases of foreign bodies. Emphasis was laid on the value of bronchoscopy in the diagnosis of bronchial neoplasms. In bronchial adenoma in which the tumor is attached by a narrow base and is readily accessible to bronchoscopic instrumentation, its removal by this means was preferred. In bronchopulmonary suppuration bronchoscopy is important to determine the presence or absence of obstruction, and to secure specimens of bronchial secretions for bacteriologic study and antibiotic sensitivity tests. Bronchoscopy can be done by any physician who will qualify himself by special training and practice. Refined technique enables this procedure to be done safely and efficiently with a minimum of discomfort. The bronchoscope is a bronchial speculum indispensable in the diagnosis and treatment of bronchial disease, which can be used by the thoracic surgeon or delegated to the bronchoesophagologist. A consideration of bronchoscopy versus surgery should be avoided and an attitude of bronchoscopy plus surgery versus the disease fostered.

Broyles [27c] compared the association of bronchoscopy and chest surgery to the association of laryngoscopy and laryngeal surgery. The endoscopist belongs to a chest team along with the surgeon, roentgenologist, physician, and pathologist, each of whom has a function in the diagnostic and therapeutic problem. A single finding in any one of these fields can afford the solution to a puzzling lung picture. Bronchoscopy is an adjunct of chest surgery, and one use is to select patients suitable for chest surgery. For patients requiring surgery bronchoscopy not only aids in the diagnosis but also gives information to the surgeon relative to the physical condition

of the lower respiratory tract. During operations or in the postoperative state, endoscopic therapy can mean the difference between life and death. If a thoracic surgeon is interested and trained in bronchoscopy, there should be no objection to his performing this service, but in large clinics the amount of endoscopic work and chest surgery is so great that it is difficult for one department to do both efficiently. Since competent endoscopy requires long training, constant practice, and a large quantity of delicate equipment for best results, it should be under the direction of one interested primarily in its use and development.

BRONCHOSCOPY IN RELATION TO BRONCHOPULMONARY DISEASES

Putney [28] reviewed the bronchologic aspects of pulmonary disease and emphasized the value of bronchoscopy in diagnosing obscure pulmonary disease; in establishing the etiology of bronchial obstruction, both complete and partial, and in determining the cause of unexplained pulmonary symptoms.

Bronchoscopy was performed by Mori [29] on 537 patients for treatment of bronchial tumors, for treatment of acute and chronic suppurations, for removal of foreign bodies, and for bronchial aspiration after pulmonary resection. Examination of bronchoscopically removed material gave positive cytologic results in 43% of the cases, whereas the results of examination of the sputum from the same patients were positive in only 21%. In some cases in which a definite diagnosis was not possible bronchoscopy disclosed changes in the tracheobronchial tree which could be interpreted as malignant involvement. In cases of recent acute suppuration, intrabronchial therapy by means of aspiration, lavage, and instillation of fluids, chemotherapeutic drugs, and antibiotics brought improvement and in many cases complete recovery. In cases of chronic suppuration, intrabronchial therapy reduced cough, expectoration, and fever and improved the patient's general condition, thus making surgical intervention safer. Bronchoscopy also proved valuable preoperatively and postoperatively for the removal of secretions and exudates. Contraindications to bronchoscopy were aneurysm of the aorta, Pott's disease, cardiac decompensation, and tuberculous, syphilitic, and neoplastic laryngitis.

BRONCHOSCOPY IN THE NEWBORN

Bell [30] advocated universal use of bronchoscopy on the newborn not responding to conservative therapy and those beginning to show signs of exhaustion. Bronchoscopy should not be used as the last resort, and the trial period of conservative treatment should not be prolonged to the point of jeopardizing the viability of the cerebral cell structure. Resuscitation by bronchoscopy should be performed as soon as the usual methods of resuscitation appear ineffective.

In a review of 137 consecutive autopsies Ende and Ziskind [31] found six cases in which the cause of death was directly due to asphyxia from tracheobronchial secre-

28. Putney, F. J.: Bronchologic Aspects of Pulmonary Disease, Pennsylvania M. J. **55**:1103 (Nov.) 1952.

29. Mori, D.: Bronchoscopy and Intrabronchial Therapy in Surgical Bronchopulmonary Diseases, Gior. ital. chir. **8**:322 (May) 1952.

30. Bell, H. L.: The Role of Bronchoscopy in Resuscitation of Asphyxia of the Newborn, Eye, Ear, Nose & Throat Month. **31**:601 (Nov.) 1952.

31. Ende, N., and Ziskind, J.: Asphyxia by Tracheobronchial Secretions, Surg. Gynec. & Obst. **94**:57 (Jan.) 1952.

tions. The mechanism of the process appeared to have been that of various insults to the respiratory system until a depression of the cough reflex occurred.

LARYNGEAL COMPLICATIONS OF INTUBATION

After intubation of 143 patients with narcotic poisoning, Dam and Zwergius [32] observed 16 with slight transient laryngeal complications, 7 with serious complications, and 10 with obstructing complications. In four of those with obstructing complications both subjective and objective symptoms soon disappeared, four patients continued to have symptoms in spite of long-continued treatment, one patient died from poisoning shortly after admission, and one died months later from laryngeal complications. The following precautions for the reduction of laryngeal complications from intubation of patients with narcotic poisoning were suggested: Intubation should be as brief as possible, soft and relatively small caliber Magill tubes should be used, the tube should be sterile and lubricated before use, and intubation itself should be carried out as gently as possible. Blind intubation, the use of a mandrin, and intubation for more than four days were condemned. Patients were intubated for 24 hours without danger of complications, but after this length of time the larynx began to show evidence of change.

Brown [33] reported a case of bilateral granuloma of the larynx following intubation in which recovery was spontaneous. The degree of peduncular formation of the tumor appeared to be diagnostic of the amount of healing that was progressing in the basic traumatic lesion.

A case of bilateral granuloma of the larynx due to intratracheal anesthesia was reported by Liebermen.[34] Hoarseness became apparent five days after the operation, and five weeks later, after the development of severe hoarseness, two large granulomas attached to the posterior thirds of the vocal cords by broad bases were found. Pedunculation occurred in approximately a month, and the granulomas were then removed.

Moore and Tolan [35] found that 9 of 116 patients had postoperative hoarseness attributable to anesthesia induced by the translaryngeal or transtracheal method. In addition to the anesthesia, nasal intubation was employed. Part of the laryngeal complication may have been due to trauma from the blind intubation.

ACUTE LARYNGOTRACHEOBRONCHITIS

Negus [36] classified the causes of acute tracheobronchitis as (1) nonspecific infection, (2) diphtheria, (3) vegetable foreign bodies, and (4) irritating oils and gases. The pathologic factors common in all cases are swelling of the mucosa and produc-

32. Dam, W. N., and Zwergius, E.: Laryngeal Complications After Protracted Endotracheal Intubation in Patients with Narcotic Poisoning, Nord. med. **48**:1095 (Aug. 8) 1952.

33. Brown, L. A.: Granuloma of Larynx Following Intubation: Spontaneous Recovery, A. M. A. Arch. Otolaryng. **56**:521 (Nov.) 1952.

34. Liebermen, G. E.: Bilateral Granuloma of the Larynx Due to Intratracheal Anesthesia, A. M. A. Arch. Otolaryng. **56**:204 (Aug.) 1952.

35. Moore, D. C., and Tolan, J. F.: Anesthesia for Long or Technically Difficult Ophthalmologic and Otolaryngologic Surgical Procedures, A. M. A. Arch. Otolaryn. **55**:350 (March) 1952.

36. Negus, V. E.: Acute Tracheo-Bronchitis, Thorax **7**:36 (March) 1952.

tion of secretion, and sometimes there is sloughing of the epithelium. Four general principles of treatment were listed: (1) removal of the cause by bronchoscopy in the case of a foreign body or aspiration of oil, neutralization of irritating gases, and control of bacterial infection by appropriate antibiotics; (2) relief of laryngeal obstruction, which can be brought about by reduction in the inflammatory swelling caused by bacteria by utilizing medical measures, bronchoscopy, and tracheotomy; (3) removal of secretions, liquefaction being obtained by means of nebulized water with wetting agents in a mechanical humidifier and humidification of the room atmosphere, with aspiration if needed through the bronchoscope or tracheostome; (4) facilitation of the passage of gases through the alveolar epithelium by introducing oxygen in helium, which not only allows oxygen to pass in, but helps to remove carbon dioxide.

Gilbert and his co-workers [37] cited their experience with 2,602 patients with nondiphtheritic infectious croup treated during the past 12 years. It was found that despite recent advances in antibiotic therapy surgical intervention to relieve the cyanosis and anoxemia was necessary. Patients with acute catarrhal laryngotracheitis responded well to humidification of the air and antibiotic therapy. Those with subglottic exudative obstructive laryngotracheitis required endoscopic aspiration of exudate and mechanical removal of accumulated crusts in many instances. Most of the patients with subglottic edematous obstructive laryngotracheitis and supraglottic edematous obstructive laryngitis required tracheotomy. Most of the patients in which the obstruction involved the bronchi and the bronchioles died in spite of tracheotomy, because this only partially relieved the anoxemia. Pneumothorax and pneumomediastinum occurred as complications of respiratory obstruction and were more frequently found after tracheotomy. The incidence of these complications was reduced by performing tracheotomy while the bronchoscope was in situ, thus allowing an adequate airway during surgery. In this series the case fatality was reduced from 23% in 1928 to 0.5% in 1950. The decline in fatality was attributed to the following factors: early laryngoscopy; proper classification of cases; adequate administration of antibiotics; appropriate use of steam and oxygen; tracheotomy performed at the appropriate time, with an airway in situ during the operation; careful postoperative care of tracheotomized patients, with particular attention to the aspiration of accumulated secretions in the airway, and constant awareness of the possibility of a complicating pneumothorax and pneumomediastinum.

Ten patients with severe laryngotracheitis were selected by Turner and Morgan [38] for evaluation of corticotropin therapy. All were given sedation, antibiotic therapy, and croupette tents, and after a period of observation five of the patients received an intramuscular injection of corticotropin. In the patients treated with this hormone no appreciable benefit was detected.

Emery [39] discussed the incidence of acute laryngotracheobronchitis and the pathologic findings in 650 autopsies during the past four years. Among these autopsies, there were 119 cases of bronchopneumonia, 41 cases of chronic lung infections

37. Gilbert, J. G.; Kasnetz, J.; Rosenthal, I. M., and Mazzarella, L.: Infectious Nondiphtheritic Croup, A. M. A. Arch. Otolaryng. **55**:566 (May) 1952.

38. Turner, J. A., and Morgan, E. A.: Corticotropin (ACTH) in the Treatment of Acute Laryngotracheitis, A. M. A. Am. J. Dis. Child. **83**:440 (April) 1952.

39. Emery, J. L.: Acute Laryngotracheobronchitis in Children, Brit. M. J. **2**:1067 (Nov. 15) 1952.

secondary to inhalation of regurgitated material, and 35 of acute tracheobronchitis. In 3 of the cases the condition was due to influenza, measles, or virus infection and the patients were children up to 12 years of age. Twenty-nine cases occurred in infants between 6 and 24 months old. The thickened viscous secretions accounted for the clinical picture, and death was due to mechanical obstruction. The etiology is not known, and the author feels that chemotherapy is not important in the treatment but that the maintenance of the airway is fundamental.

A case of acute infectious laryngotracheobronchitis in an infant with recurrent episodes of respiratory distress was reported by Simmons.[40] It was found that avoidance of house dust and desensitization to it broke off the respiratory distress abruptly, and this method of treatment was advocated for patients who do not respond readily to the commonly accepted methods of treatment.

In discussing stridor in infancy Wilson [41] pointed out the anatomical and physiological differences between the infant and the adult larynx. It was thought that the cause of laryngomalacia was not immaturity of the larynx but more likely a tracheal stenosis combined with immaturity and softness of the tissues. As a sign of a general systemic disease laryngismus occurs suddenly, and the spasmodic nature of the stridor should help differentiate this condition from congenital laryngeal stridor. The author states that after the decline of the incidence of diphtheria there was in Dublin, Ireland, a marked increase of acute laryngotracheobronchitis. Whether this increase was actual or due to better diagnosis was debatable. Acute laryngotracheobronchitis was treated with chemotherapy and humidification together with tracheostomy and bronchoscopy. When the obstruction to respiration was in the trachea, the nature of the sound was characteristic. The stridor was either double or predominantly expiratory, as in tracheomalacia, vascular ring, and tracheal and bronchial foreign body. A broad generalization was made that inspiratory stridor usually has its origin at or above the vocal folds, while expiratory or double stridor as a rule is caused by a lesion below this level.

STENOSIS OF LARYNX AND TRACHEA

The use of an endotracheal metallic prosthesis in the treatment of stenosis of the upper trachea was investigated by Harkins.[42] A metallic cylinder, open at both ends, made of an alloy of cobalt and chromium was used on a series of dogs for periods varying from 2 to 85 days and in the trachea of one patient for two successive periods of 6 months. While the cylinder served as a satisfactory airway and splint, it caused interference with the ciliary mechanism of the trachea. In most instances a loss of cilia and even the superficial layers of epithelium was found surrounding the tube. Within the lumen of the prosthesis there was an accumulation of dry mucus, which produced slight narrowing of the airway. After removal of the obstructing scar tissue the tracheal wall healed satisfactorily around the tube. The metallic alloy in the tube did not show any gross evidence of chemical erosion after six months' contact with the tissues.

40. Simmons, F. H.: Preventive Treatment of Laryngotracheobronchitis in Child of 22 Months, A. M. A. Arch. Otolaryng. **56**:209 (Aug.) 1952.

41. Wilson, T. G.: Stridor in Infancy, J. Laryng. & Otol. **66**:437 (Sept.) 1952.

42. Harkins, W. B.: An Endotracheal Metallic Prosthesis in the Treatment of Stenosis of the Upper Trachea, Ann. Otol. Rhin. & Laryng. **61**:663 (Sept.) 1952.

A method for the treatment of chronic laryngeal stenosis in children with a rubber Nélaton catheter was described by Machado.[43] Recovery was obtained in three of the four patients treated, and the fourth patient was still undergoing treatment. A Nélaton bougie was left in place in the larynx for approximately one week, at the end of which time it was removed and a larger size substituted. As soon as the bougie that obtained the desired lumen was tolerated, it was left in place for three weeks, being changed every week, and at the end of this time it was removed and decannulation proceeded with.

TRACHEITIS

Roentgen treatment of the thyroid gland has produced injury to the trachea, and Silberberg and co-workers [44] demonstrated experimentally that the same result can be produced by radioactive iodine. A lesion with the typical microscopic features of radiation reaction developed in mice two to three months after treatment was begun with I^{131}, with resulting fatal endotracheitis and peritracheitis.

TRAUMATIC RUPTURE OF TRACHEA

Henry [45] reported a case of traumatic rupture of the lower trachea with stenosis following a severe chest injury. There were shock, dyspnea, interstitial emphysema over the neck and chest, and expectoration of blood. Tracheal obstruction becomes apparent when the clinical and radiological findings show a symmetrical disturbance of the mechanics of the chest. Localization of the site of the injury in the respiratory tree may be difficult, but bronchoscopic examination should be made early to determine the site of the injury. Usually it will be necessary to follow this with a low tracheotomy and the use of suitable tubes to maintain the airway. Stenosis may be kept in check by the use of as large a tracheotomy tube as possible, bronchoscopic dilatations, and the passage of tracheal dilators through the tracheotomy wound. When there is a loss of tracheal rings the choice of treatment is still obscure.

HUMIDIFICATION OF AIR PASSAGES

Negus [46] discussed the importance of humidification of the air passages and stated that excessive moisture plugs the smaller bronchi in cases of bronchitis, bronchiectasis, and lung abscess. Insufficiently moistened air reaches the air passages in cases of atrophic rhinitis; after the repeated use of vasoconstrictors; after a tracheotomy or laryngectomy; in dry, arid desert regions, and the higher altitudes of mountains; in hot operating rooms, not properly air-conditioned, and after operation when too much atrophine has been administered. The comfortable relative humidity of the air was given as 45 to 50%, but under certain conditions a higher level was desirable. The addition of moisture to the air, bringing the relative humidity to 70%, a room temperature kept at 67 F. were considered optimum in the treatment of pathologic conditions. After tracheotomy or laryngectomy humidification is necessary until the

43. Machado, R.: Permanent Retrograde Progressive Dilatation: New Treatment for Chronic Laryngeal Stenosis in Children, A. M. A. Arch. Otolaryng. **56**:504 (Nov.) 1952.

44. Silberberg, R.; Silberberg, M., and Dixon, F. J.: Obliterating Tracheitis, Complication Following Administration of Radioactive Iodine, J. Lab. & Clin. Med. **39**:256 (Feb.) 1952.

45. Henry, G. A.: Traumatic Rupture of the Lower Trachea with Stenosis: A Case Report, Ann. Otol. Rhin. & Laryng. **61**:1114 (Dec.) 1952.

46. Negus, V. E.: Humidification of the Air Passages, Thorax **7**:148 (June) 1952.

tracheobronchial tree has had time for adaptation. In acute tracheobronchitis the secretions are so thick and viscid that obstruction may develop, and humidification is a great aid. Hot steam is not desirable except by inhalation from a jug, since there is precipitation of droplets in the colder air, but cold moisture is beneficial. To reduce the surface tension of water and thus facilitate its evaporation, various wetting agents can be used, e. g. sodium lauryl sulfate in 0.1% solution. Additional oxygen can be supplied as needed in the individual case.

TRACHEOTOMY

Harris [47] stated that, while bronchoscopy was effective in chronic cases of poliomyelitis with atelectasis, it did not give the assurance of a continued free airway in the acute cases, for which tracheotomy was necessary. Recent studies have indicated that there has been a great reduction in the respiratory fatality rate for poliomyelitis owing to the early performance of tracheotomy as a prophylactic measure in many cases. Tracheotomy was advocated for patients with adductor paralysis of the vocal cords, especially those with swallowing difficulty or those showing marked listlessness or coma. Patients with severe swallowing difficulty were materially helped by tracheotomy, so that suction could be used through the tube to remove material aspirated from the pharynx.

The performance of a tracheotomy on all patients with cerebral injury who are comatose or semicomatose and show signs of respiratory distress or cyanosis was advocated by McCart [48] when the simple procedures for the removal of secretions from the tracheobronchial tree have failed. The indications for tracheotomy in the case of brain injury vary and are not the same as those for obstructive laryngeal dyspnea. Patients with relaxed pharyngeal musculature, loss of swallowing and gag reflexes, and crusting in the pharynx and larynx with labored breathing necessary to overcome partial respiratory obstruction may require tracheotomy. Since unconscious patients are often very sensitive to slight degrees of oxygen lack and minor degrees of cyanosis may escape detection, an artificial opening in the trachea may be necessary.

The causes, clinical manifestations, and treatment of anoxia and anoxemia in obstruction of the upper and lower air passages was discussed by Weller,[49] and a method for intranasal tracheal catheter aspiration was described. An analysis of the reasons for 30 tracheotomies performed to relieve obstruction of the air passages revealed that 24% were done for acute respiratory obstruction, 43% for prevention of respiratory emergencies, and 33% for the treatment of tracheobronchial stasis. The clinical manifestations of anoxia were listed as follows: hyperpnea, dyspnea, cyanosis, indrawing, restlessness, cough, mental symptoms, and coarse râles over the trachea. In relieving lower air passage obstruction, endoscopic aspiration either by catheter or through the bronchoscope is a valuable method of treatment. Likewise, the avoidance of general anesthetics, narcotics, and sedatives was stressed.

47. Harris, H. H.: Clinical Evaluation of Tracheotomy in Respiratory Complications of Poliomyelitis, A. M. A. Arch. Otolaryng. **56**:385 (Oct.) 1952.

48. McCart, H.: Place of Tracheotomy in Head Injuries, Ann. Otol. Rhin. & Laryng. **61**:593 (June) 1952.

49. Weller, W. A.: Obstruction of the Air Passages, Ann. Otol. Rhin. & Laryng. **61**:1080 (Dec.) 1952.

HEMOPTYSIS

Moersch [50] studied the diagnostic significance of hemoptysis and the frequency of its occurrence in pulmonary disease in 670 cases in which bronchoscopy was performed. Of this group a history of hemoptysis was obtained in 29.8%. In the cases in which there was a history of hemoptysis, the most frequently encountered lesions were malignant tumors of the trachea, bronchus, or lung and bronchiectasis. A malignant tumor of the trachea, bronchus, or lung was present in 29.5% of the cases of hemoptysis. Bronchiectasis was second in frequency, occurring in 26.5% of the cases in which there was a history of hemoptysis. In the cases in which bronchiectasis was associated with hemoptysis the average age was higher than in those in which bronchiectasis occurred without hemoptysis. In 7.5% of the cases in which there was a history of hemoptysis the cause could not be found. In cases in which clinical investigation, including roentgenographic examination of the chest, fails to disclose any cause for the hemoptysis, there is an excellent chance that a serious pulmonary lesion will not subsequently develop. The severity of the bleeding is no indication of the nature of the underlying lesion. Diagnostic bronchoscopy was advocated for all patients with hemoptysis, to aid in determining not only the etiology but also the site of the bleeding.

While recognizing the immediate need of suspecting either carcinoma or tuberculosis in cases of hemoptysis, Shanks [51] discussed bronchoscopy in the presence of hemoptysis and reported three cases, in two of which the hemoptysis was due to foreign bodies in the bronchus and in the third proved to be of unknown etiology.

Vinson [52] studied a group of 48 patients with pulmonary hemorrhage caused by simple erosion of the wall of a small bronchus. There were no symptoms that suggested previous chronic pulmonary disease in any of the patients, but a number had associated essential hypertension. Results of physical and roentgen examinations were normal unless altered by the presence of blood in the tracheobronchial tree. The bronchoscopic findings indicated that bleeding was from the posterior or posterolateral division of the lower lobe bronchus in every instance except one, in which the bleeding originated from the right upper lobe. Treatment consisted of exact localization of the site of bleeding, dilatation of the bronchus, mechanical curettement of the bronchial wall, instillation of phenylephrine (Neo-Synephrine) hydrochloride 1% or topical application of thrombin and insufflation of a mixture of sulfanilamide and sulfathiazole powder into the affected bronchus.

Two cases of massive hemoptysis from arteriobronchial fistula in tuberculous patients were reported by Berard and deBeaujeu.[53] It was noted on bronchoscopic examination that the mucosa of the right upper lobe bronchus was red and congested, but precise information concerning the origin of the hemorrhage or its pathogenesis was not provided. The hyperemic state of the mucosa on endoscopic examination prevented accurate interpretation.

50. Moersch, H. J.: Clinical Significance of Hemoptysis, J. A. M. A. **148**:1461 (April 26) 1952.

51. Shanks, J.: Bronchoscopy and Hemoptysis, Eye, Ear, Nose & Throat Month. **31**:492 (Sept.) 1952.

52. Vinson, P. P.: Simple Bronchial Erosion as Cause of Pulmonary Hemorrhage, J. A. M. A. **150**:840 (Nov. 1) 1952.

53. Berard, M., and deBeaujeu, J.: Massive Hemoptysis from Arteriobronchial Fistula in Pulmonary Tuberculosis, Thorax **7**:152 (June) 1952.

A rare cause of hemoptysis was reported by Tait and Corridan [54] in an adult with idiopathic pulmonary hemosiderosis. The clinical picture was essentially that of recurrent hemoptysis of unknown origin, and the diagnosis was made at autopsy.

Citing three cases, Maurer [55] pointed out that atelectasis associated with a history of cough and hemoptysis was thought to be the result of primary bronchogenic carcinoma until extrabronchial compression by calcified parabronchial lymph glands was demonstrated to be the cause. The importance of an endoscopic examination prior to all bronchographic studies and prior to thoracotomy was emphasized. The difficulties encountered in diagnosis were considered, and it was stated that the findings in patients with atelectasis may be identical with those in extrabronchial pulmonary carcinoma and bronchial compression due to calcified lymph glands.

PULMONARY ATELECTASIS

Barnhart and his co-workers [56] reported a relatively rare case of dyspnea and right upper lobe atelectasis developing in an 8-month-old infant with an acute upper respiratory infection. On the fourth day the infant coughed up a bronchial cast about 3 cm. long, and there was prompt recovery.

Templeton [57] reported a case of obstruction of the bronchus in the remaining portion of the left upper lobe after left lower lobectomy and lingulectomy because of external compression from a ring of enlarged lymph nodes. At operation the tissues used to reinforce the bronchial stump contained lymph nodes, which formed a fixed lymphatic ring about the bronchus when inflammation secondary to the operation developed in the nodes. The pressure obstruction was sufficient to cause symptoms and retention of secretion.

Bronchoscopic aspiration was performed by Gans [58] in 50 consecutive cases of atelectasis in children ranging in age from 17 days to 12 years. Of the total of 67 collapsed lobes, 34 cleared in 10 days, 13 cleared in a month, and 20 failed to clear. In 13 of 21 tuberculous children the collapse was found to be due to an enlarged gland pressing on one or more of the bronchial openings. In 83% of the nontuberculous patients bronchoscopic aspiration led to reventilation of the collapsed lobe within one month. The results were better when the collapse resulted from pressure by glands on a bronchus. When reexpansion of the collapsed lobes can be obtained by bronchoscopic aspiration, bronchiectasis can be prevented in certain cases.

In atelectasis due to thick, viscid secretions, bronchoscopic aspiration opens up the larger bronchi but does not completely clear the distal obstructed areas. Even though there might be some local irritative action from the endobronchial instillation

54. Tait, G. B., and Corridan, M.: Idiopathic Pulmonary Haemosiderosis, Thorax **7**:302 (Dec.) 1952.

55. Maurer, E. R.: The Surgical Significance of Calcified Parabronchial and Paratracheal Lymph Glands, J. Thoracic Surg. **23**:97 (Jan.) 1952.

56. Barnhart, R.; McCue, E., and Vinson, P. P.: Acute Fibrinous Bronchiolitis with Partial Pulmonary Atelectasis in an Infant 8 Months of Age, Virginia M. Month. **79**:560 (Oct.) 1952.

57. Templeton, J. Y., III: Bronchial Obstruction with Chronic Atelectasis and Pneumonitis Due to Hilar Lymphadenitis After Lobectomy and Lingulectomy, J. Thoracic Surg. **23**:169 (Feb.) 1952.

58. Gans, B.: Bronchoscopic Treatment of Atelectasis in Children, Arch. Dis. Childhood **27**:254 (June) 1952.

of the physiological enzyme trypsin, Peck and Levin [59] found that it aided in loosening the viscid secretions in the smaller bronchi, particularly in patients with bulbar poliomyelitis. It was used to advantage by bronchoscopic instillation in two cases of bronchial and bronchiolar obstruction due to bulbar poliomyelitis. After thorough aspiration of the tracheobronchial tree the patient was placed on the affected side at about a 30 degree angle and the trypsin solution slowly introduced through the branch oxygen inlet of the bronchoscope. The instrument was removed and the patient allowed to remain in the same position for one hour, at the end of which time the bronchoscope was reintroduced and all secretions aspirated. The endobronchial use of trypsin does not eliminate other methods of combating chronic atelectasis, including tracheotomy, but may prove beneficial in selected cases.

FOREIGN BODIES IN THE AIRWAY

In reviewing the historical aspects of foreign bodies in the air and food passages, Clerf [60] pointed out that the early medical literature contained little reference to foreign bodies in the air passages and that in practically all the earlier cases the obstruction was esophageal in origin. The first systematic study of this subject was made by Samuel D. Gross in 1854, when many of the symptoms and certain of the physical signs were described. With the development of roentgenology the diagnosis of foreign body became a roentgenologic problem to a great degree. Of interest was the habit of primitive people of holding live fish in their mouth and crushing the head with their teeth, so that frequently the fish in its struggle slipped from the individual's grasp and lodged in the esophagus or larynx. In every case of impaction of a live fish in the food passages the intruder entered head first. This is to be expected, since it is impossible to swallow a fish tail foremost because of the direction of the fins. To Goodall belongs the credit of calling attention to the part played by the carina in influencing the passage of foreign bodies in their descent through the bronchial tree. The mechanism underlying the production of obstructive emphysema was first described by W. F. Manges. Burns was the first to notice a tendency of certain foreign bodies to move up and down the trachea. The methods of treatment employed in the 19th century were considered from a medical and surgical standpoint. The medical treatment consisted of measures to promote the expulsion of the foreign body and to prevent the effects of its presence. Tracheotomy was advocated for foreign bodies in the air passages at an early period in the development of medicine. The early treatment of foreign bodies in the esophagus commonly consisted of the use of some form of bougie to push the offender down into the stomach. Such instruments as the probang and the coin catcher were used. Hippocrates first suggested intubation of the larynx and trachea in cases of impending asphyxiation. Killian was credited with the first successful bronchoscopy, but the idea of using a tube was not his but belonged to Kussmaul. Jackson improved the instrumentarium and brought it to its present high state of perfection. In addition, he made peroral endoscopy an important part of medical science.

59. Peck, M. E., and Levin, S.: Atelectasis: Physiopathology and Treatment, J. Thoracic Surg. **24**:619 (Dec.) 1952.

60. Clerf, L. H.: Foreign Bodies in the Air and Food Passages, Ann. Otol. Rhin. & Laryng. **61**:5 (March) 1952.

In an x-ray chest survey of patients in California mental institutions, 28 of 45,000 patients were found by Oechsli [61] to have subcutaneous, intrapulmonary, and mediastinal foreign bodies. Eighteen had forced sewing needles or straight pins under the skin, six had pins or screws in the bronchi, and four had pins in the mediastinum.

Jackson [62] found the occurrence of grasses as foreign bodies in the tracheobronchial tree to be extremely rare and listed the total number recorded in the literature as 35, including 18 of his own cases. It was urged that the botanical classification of the spike or spikelet be included in all future case reports. The cases of grass lodged in the tracheobronchial tree were divided into two distinct types. In one type the spike remained in the bronchus until removed bronchoscopically. In the other type the spike was driven through the lung and thoracic wall and was extruded on the skin surface, in most cases without empyema or pneumothorax. In the latter type the source of the driving power was the thoracic muscles, the movement being greatly accelerated at intervals by the tussive squeeze. In 34 patients prompt recovery resulted after bronchoscopic removal or extrusion of the foreign body. In the other recorded case the patient died of advanced pulmonary tuberculosis, which was present before the aspiration, and death occurred nine months after extrusion of the grass spike.

Two cases of foreign body in the left bronchus causing a mediastinum shift to the right were recorded by Equen and his associates.[63]

Emerson and Bardford [64] recorded the case of a 9-month-old boy who aspirated a capsule of aureomycin while the mother attempted to push the capsule down his throat. This incident resulted in moderate obstruction of the airway secondary to edema of the mucosa.

Two cases of intrabronchial foreign bodies whose presence was of long duration were described by Boettner and co-workers.[65] In one case a piece of bone remained for one and a half years in the right lower lobe bronchus, producing cough, fever, and suppuration. The symptoms disappeared with the endoscopic extraction of the bone, which exhibited no gross pathologic change. In the second case a piece of meat was lodged in the bronchus of the right lower lobe for four years, causing bronchiectasis. In the histologic examination the muscle fibers of the meat were found to be well conserved after remaining this length of time in the bronchial tree.

Triangulation roentgenoscopy was used by Dorenbusch and Roberts [66] in the removal of radiopaque foreign bodies beyond endoscopic vision. The Alnico bronchoscopic magnet has been found easily maneuverable in the smaller bronchi and some-

61. Oechsli, W. R.: Foreign Bodies Discovered by Chest Roentgen Survey, Am. J. Roentgenol. **68**:725 (Nov.) 1952.

62. Jackson, C.: Grasses as Foreign Bodies in the Bronchus and Lung, Laryngoscope **62**:879 (Sept.) 1952.

63. Equen, M.; Buckner, F.; Roach, G., and Brown, R.: Dextrocardia Secondary to Foreign Body in Left Bronchus, South. M. J. **45**:16 (Jan.) 1952.

64. Emerson, E. B., and Bardford, W. L.: Accidental Inhalation of Aureomycin Capsule, A. M. A. Am. J. Dis. Child. **84**:344 (Sept.) 1952.

65. Boettner, J. M.; Rivero, M.; Perito, M. A.; Codas, R.; Llamosas, N., and Maas, C.: Two Cases of Intrabronchial Foreign Bodies of Long Duration, Dis. Chest **22**:219 (Aug.) 1952.

66. Dorenbusch, A. A., and Roberts, W. E.: Bronchoscopic Removal of a Foreign Body with the Aid of Triangulation Roentgenoscopy, Ann. Otol. Rhin. & Laryng. **61**:83 (March) 1952.

what less traumatic than rigid forceps but has not taken the place of the latter instrument. In the method of triangulation roentgenoscopy a single fluoroscopic screen was used, and all dimensions to the right and left of and above and below the foreign body could be seen on a single screen by the roentgenologist. No shifting from the vertical plane to the horizontal plane was needed, as in biplane roentgenology, and the position of the forceps and magnet in relation to the foreign body could be visualized from one position.

Two cases of carcinoma of the bronchus occurring at the site of retained metallic foreign bodies were recorded by Siddons and MacArthur.[67] In both cases the foreign bodies were war missiles, and the patients died of carcinoma 32 and 35 years after injury.

A method of extracting bronchial foreign bodies by the use of parallax fluoroscopy was described by Hellemond and Waar.[68] This method has no technical or clinical advantage over biplane fluoroscopy but does not require the expensive and complicated x-ray apparatus needed for the latter. Parallax fluoroscopy has apparently proved useful on the Continent.

BRONCHOPULMONARY ASPERGILLOSIS

Eight cases of bronchopulmonary aspergillosis were described by Hinson, Moon, and Plummer.[69] They proposed a classification dividing bronchopulmonary aspergillosis into three types: saprophytic, allergic, and pyemic. Included were three cases of a variety not previously recognized. In these three cases there were recurrent attacks of fever, with radiographic evidence of collapse and consolidation in different parts of the lung, purulent sputum, and an elevated blood eosinophile count. This type of bronchopulmonary aspergillosis was thought to be caused by sensitization of the host to the fungus. When this condition occurs the reaction may be severe enough to produce secondary pathologic changes, with prolonged illness or death. Bronchoscopic aspiration was used to confirm the fact that the organism originated from the affected lobe. Bronchoscopy also revealed in some cases a polypoid mass obstructing the lumen of the bronchus, leading to collapse and atelectasis or, in other cases, edema of the mucosa and a lumen filled with tenacious material or mucopurulent secretion. In two cases subsequent bronchoscopy revealed that the polypoid mass had disappeared, although the bronchus was still infected by aspergillosis. Bronchial biopsy was performed in one case, and the organism was demonstrated in the crypts of the mucous glands. Bronchoscopy proved invaluable in confirming the diagnosis. The fungus can grow in any part of the bronchial tree, but especially where there is some preexisting lesion, such as bronchiectasis or tuberculosis, with stagnation of secretions or hemorrhage. In this type of case the fungus acts as a pure saprophyte and has no clinical significance.

67. Siddon, A. H. M., and MacArthur, A. M.: Carcinomata Developing at Site of Foreign Bodies in Lung, Brit. J. Surg. **39**:542 (May) 1952.

68. Hellemond, K. V., and Waar, C. A. H.: The Use of Parallaxfluoroscopy in Bronchoscopical Extraction of Corpora Aliena in the Lower Respiratory Tract, Acta oto-laryng. **42**:460 (Dec.) 1952.

69. Hinson, K. F. W.; Moon, A. J., and Plummer, N. S.: Bronchopulmonary Aspergillosis, Thorax **7**:317 (Dec.) 1952.

PULMONARY HISTOPLASMOSIS

Wilson and Duryea [70] presented a case of chronic cough of thirty years' duration which had followed influenza. The patient was considered to have had arrested pulmonary tuberculosis for approximately 20 years, although acid-fast bacilli were never recovered. At the end of this time the diagnosis of pulmonary histoplasmosis was made on the basis of repeated recovery of the organism in sputum cultures.

PULMONARY CRYPTOCOCCOSIS

A case of pulmonary cryptococcosis was recorded by Cruickshank and Harrison.[71] A chronic cough was present, and the roentgenogram revealed an opacity in the right middle and lower lobes. On bronchoscopy a rounded mass was seen just inside the orifice of the middle lobe bronchus. On biopsy and culture of material obtained at bronchoscopy, numerous morphologically typical Cryptococcus neoformans fungi were present. Because the fungus was insensitive to all the antibiotics pneumonectomy was performed.

HODGKIN'S DISEASE

Efskind and Wexels [72] reported three cases of pulmonary Hodgkin's disease with cavity formation, all in women. The respiratory symptoms were very slight. In none of the cases was general lymphadenopathy present, although retrosternal lymph glands were found to be enlarged. In one case the diagnosis was verified by the finding of Reed-Sternberg cells in cytologic smears of material obtained at bronchoscopy. The treatment for pulmonary Hodgkin's disease was the same as that advocated for Hodgkin's disease elsewhere: roentgen therapy, use of nitrogen mustard (methyl bis-[β-chloroethyl] amine hydrochloride), or surgical removal of a localized focus. In spite of the rarity of pulmonary Hodgkin's disease with cavitation, it must be thought of in the differential diagnosis of the commoner lesions in the lung, and effective histologic examination of the bronchial secretions obtained at bronchoscopy may be helpful in arriving at the correct diagnosis.

TUBERCULOUS TRACHEOBRONCHITIS

In studying a series of 434 children with various forms of tuberculosis, Daly and his associates [73] found that the commonest symptom suggesting endobronchial disease was persistent cough, which was sometimes paroxysmal or brassy. Wheezing occurred as a complaint in one-fourth of the patients. Bronchoscopy was done repeatedly, a new technique of anesthesia being used, in which thiamylal (Surital) sodium was administered rectally in a dose of 1 gm. per 50 lb. of body weight in a 2% solution, and preliminary topical anesthesia of the tracheobronchial tree was induced by aerosol administration of 0.5% tetracaine (Pontocaine) solution con-

70. Wilson, H. M., and Duryea, A. W.: Pulmonary Histoplasmosis, Dis. Chest **21**:346 (March) 1952.

71. Cruickshank, D. B., and Harrison, G. K.: A Case of Pulmonary Cryptococcosis, Thorax **7**:182 (June) 1952.

72. Efskind, L., and Wexels, P.: Hodgkin's Disease of the Lung with Cavitation: Report of 3 Cases, J. Thoracic Surg. **23**:377 (April) 1952.

73. Daly, J. F.; Brown, D. S.; Lincoln, E. M., and Wilking, V. N.: Endobronchial Tuberculosis in Children, Dis. Chest **22**:399 (Oct.) 1952.

taining a wetting agent. The criteria for bronchoscopy in children with primary pulmonary tuberculosis were cough, wheeze, sudden increase in roentgen ray shadows suggesting obstruction or obstructive emphysema, or a report of persistently positive cultures of gastric washings from a child without significant findings on the roentgenogram or at physical examination. Repeated bronchoscopies in children with endobronchial disease revealed (1) bronchial compression without mucosal involvement, (2) edema and inflammation, and (3) ulceration and granulation. Erosion of the bronchial wall, caseous polyps, and ultimately bronchial stenosis developed in some cases. Bronchiectasis developed frequently after bronchial obstruction.

The occurrence of atelectasis or bronchial obstruction in the course of an acute respiratory infection may be due to fibrinous bronchitis. A patient with bronchial obstruction and anoxia due to acute tuberculous fibrinous bronchitis was reported by Williams.[74] At bronchoscopy inspissated tenacious bronchial casts were found, the removal of which required foreign body forceps. Tracheotomy was necessary, and a bronchial stricture and bronchiectasis subsequently developed. Bronchoscopy occupies an important place in diagnosis and treatment of acute tuberculous fibrinous bronchitis, a rare disease which may be fatal. Bronchoscopy has been infrequently used in both the diagnosis and the management of this condition, but it has the advantage of allowing removal of the recurrent casts under direct vision. Although tracheotomy is often necessary, removal of casts is not as satisfactory by this means as by removal under direct vision.

BRONCHIECTASIS AND TUBERCULOSIS

In children with bronchiectasis primary pulmonary tuberculosis may be the etiologic agent. Dickey[75] pointed out that bronchogenic complications following primary tuberculous infection should be looked for in the presence of any roentgen shadow. Treatment should be directed toward reexpansion of the atelectasis and rigid control and surgical treatment resorted to when necessary.

In a period of 15 years 250 cases of primary tuberculosis in childhood were observed by Valledor and Navarrete.[76] Bronchiectasis of varying degree was found in 70% of the cases upon bronchoscopic and bronchographic study. The incidence of bronchiectasis involving various lobes was tabulated, and the condition generally was noted in the upper lobes in tuberculous patients. In childhood bronchiectatic changes were often found to be the result of extrinsic compression and, at times, infiltration of the bronchi by enlarged lymph nodes, leading to obstruction and atelectasis and thereby inducing dilatation.

BRONCHIECTASIS

A thorough investigation of the pathology and pathogenesis of bronchiectasis was performed by Whitwell[77] on 200 consecutively removed bronchiectatic lungs

74. Williams, M. H.: Acute Tuberculous Fibrinous Bronchitis, J. Thoracic Surg. **24**:530 (Nov.) 1952.

75. Dickey, L. B.: Primary Pulmonary Tuberculosis as a Cause of Bronchiectasis in Children, Dis. Chest **21**:260 (March) 1952.

76. Valledor, T., and Navarrete, A.: Bronchiectasis in Childhood and Adult Pulmonary Tuberculosis, Dis. Chest **22**:46 (July) 1952.

77. Whitwell, F.: A Study of the Pathology and Pathogenesis of Bronchiectasis, Thorax **7**:213 (Sept.) 1952.

and lobes. More than half the specimens belonged to one of three distinctive types of bronchiectasis, which were called (1) follicular, (2) saccular, and (3) atelectatic bronchiectasis. In no instance was the bronchial dilatation considered to be reversible. It was always the result of destructive and inflammatory processes, permanent alveolar collapse, or abnormal development resulting in bronchi of wide caliber. One of the earliest and most constant features of the affected bronchi and bronchioles was the destruction of elastic tissue in the walls. Apart from the influence of allergy and sinus infection, it was agreed that normal bronchi do not dilate when subjected to various mechanical stresses and that the primary basis of bronchiectasis is a bronchial weakness due to either inflammation or developmental defects. About 10% of the specimens represented developmental anomalies. The theory that the bronchi become dilated by the contraction of bands of fibrous tissue running between them was not substantiated; neither was there any evidence uncovered to support the theory that collapse follows obstruction and dilatation occurs in the bronchi proximal to the obstruction. In contrast to follicular and saccular bronchiectasis, in which peripheral obstruction was invariable, in atelectatic bronchiectasis the bronchioles were found to be patent and could be followed into the pulmonary lobules, where the air cells were partly collapsed.

Mendez and co-workers [78] described two cases of bronchiectasis developing in infants while the patients were under medical observation. In both cases bronchial obstruction with infection was the apparent cause. In one child the obstruction developed in connection with an unexpanded lower lobe. In the other the obstruction was associated with depression accompanying a tuberculous meningitis.

In reviewing the effect of antibacterial therapy on bronchiectasis, Kassowitz and Muscato [79] found that the cases of clinically proved bronchiectasis decreased from 25 for the first 5 years of their study to 7 for the last 5 years of the study, which covered 20 years. Only 43 cases of pulmonary abscess were encountered, indicating a decided decrease since 1936. There was a simultaneous sharp decline in the death rate for lung abscess.

Overholt and Walker [80] reported a high incidence of bronchiectasis in asthmatic patients occurring either as a complication or as an etiologic factor. Bronchiectasis should always be suspected in cases of intractable bronchospasm. Seventy-six patients with severe bronchial asthma were studied, and prior to the authors' seeing these patients bronchography had been done in four, one of whom had bilateral basilar bronchiectasis. Bronchography was performed on the remaining 75 patients without ill effects, and bronchiectasis was demonstrated in 27 patients. All patients were treated by exploratory thoracotomy, and the abnormal segments were removed in 26 patients. Two patients with infectious complications were not improved by surgery, and in one patient the bronchiectasis was too extensive for removal. Twenty of the twenty-six patients were markedly improved, and seven subsequently required bronchodilator drugs.

78. Mendez, F. L.; Lehay, L. J., and Butsch, W. L.: Some Aspects of Bronchiectasis in Infants, J. Thoracic Surg. **24**:50 (July) 1952.

79. Kassowitz, K. E., and Muscato, T. H., Jr.: The Long Range Effect of Antibacterial Therapy on Pneumonia, Empyema, Bronchiectasis and Pulmonary Abscess, Dis. Chest **21**:161 (Feb.) 1952.

80. Overholt, R. H., and Walker, J. H.: Hidden or Unsuspected Bronchiectasis in the Asthmatic, Ann. Otol. Rhin. & Laryng. **61**:1198 (Dec.) 1952.

BRONCHOGRAPHY

Bronchography in children can be performed easily and safely as outlined by Wishart.[81] Endobronchial injection of iodized oil through the bronchoscope with the patient under general anesthesia and with fluoroscopic guidance was utilized. It was performed through the combined efforts of the staffs of otolaryngology, anesthesia, and radiology. Occasionally the catheter technique was employed for the cooperative child, but it was found to be impractical for many children and could not be used at all for infants. Adequate fillings of all portions of the tracheobronchial tree were obtained by this technique. The bronchography was not preceded by sedation, which interfered with the cough reflex. The rapid return of the cough reflex once administration of the anesthetic has been stopped was found desirable. No local anesthetic agent was used, but the entire procedure was carried out with the patient under general anesthesia, and ethyl chloride, ether sequence being used. After introduction of the bronchoscope anesthesia was maintained by means of a rubber tube delivering ether and oxygen through the bronchoscope. Before the iodized oil was introduced the plane of anesthesia was allowed to become lighter, so that coughing occurred and there was expulsion of purulent secretion from the distal portions of the tracheobronchial tree. This process was aided by the use of suction through the bronchoscope. Cool iodized oil was instilled through the bronchoscope by means of a metal cannula. By positioning the patient and following the directions of the fluoroscopist all portions of the tracheobronchial tree were filled with the iodized oil. After roentgen films had been taken as much of the iodized oil as possible was removed by suction, and after the patient began to react from the anesthetic the bronchoscope was removed. One lung was mapped at a time, an interval of several weeks being allowed between the bronchographies. Four risks entailed in bronchography for young children were listed: (1) the risk connected with the anesthesia, (2) that involved in the technical procedure of the introduction of the iodized oil, (3) the risk of respiratory trouble, and (4) the risk of iodine intoxication. While these dangers were recognized, they did not cause any particular concern or disastrous results.

A technique of bronchography applicable to infants and young children was outlined by Priest.[82] The following criteria were listed: (1) the airway should never be obstructed, (2) the anesthesia should be adequate to permit injection of the contrast medium under fluoroscopic control without cough or other interference by the patient, (3) there should be no fire hazard, (4) aspiration of secretions and the contrast medium from the respiratory tree should be possible, and (5) spot film technique should be used to permit instantaneous recording of the bronchographic pictures. After anesthesia is induced the bronchoscope is introduced and a plastic tube is passed through the bronchoscope into the section of lung to be outlined. The bronchoscope is then withdrawn, the plastic tube being left in place; the larynx is exposed, and an endotracheal tube is passed through the larynx alongside of the plastic tube. The latter tube is used for the anesthetic. The child is then transferred to the fluoroscopic room, where the contrast medium is introduced under fluoro-

81. Wishart, D. E. S.: Bronchography in Children, Ann. Otol. Rhin. & Laryng. **61**:505 (June) 1952.

82. Priest, R. E.: Bronchography in Infants and Children, Ann. Otol. Rhin. & Laryng. **61**:651 (Sept.) 1952.

scopic guidance. After the bronchogram has been made the contrast medium is suctioned out by means of a catheter through the endotracheal anesthetic tube or through the bronchoscope.

Cohen [83] cited two cases of local complications following bronchography by cricothyroid puncture. Infiltration of the soft tissues of the larynx occurred, resulting in rather marked laryngeal swelling. Respiratory obstruction occurred but was not sufficiently severe to require tracheotomy. In both cases difficulty was experienced during the procedure, and it was thought that the needle had slipped out of the laryngeal lumen during injection of the iodized oil.

Hentel and his associates [84] studied the effect of Ioduron B on animal tissues. This aqueous contrast medium did not appreciably damage tissues up to 12 weeks after instillation, but transitory inflammatory reactions occurred in the lungs and kidneys of the test animals.

Cohen and his associates [85] reported that transitory changes in hepatic function occurred in 60% of cases in which Ioduron B was used for bronchography. These changes occurred within a few hours in some cases and were delayed as long as six weeks in others. In 30% of the patients transitory renal function changes occurred within a few hours or a few days after the use of the drug. Both hepatic or renal transitory changes occurred in 20% of the patients. These results indicated that further investigation was necessary, even though the functional impairment was of a mild nature and transitory, before this drug is adopted in routine bronchography.

Rogers and Weems [86] considered the advantages and disadvantages of water-soluble contrast medium for bronchography in a limited number of cases. It was well suited to outline a limited number of pulmonary segments, particularly in conditions with partial bronchial obstruction. In patients for whom a survey bronchogram of both lungs in a search for minimal bronchiectasis was indicated, iodized oil was preferred.

AEROSOL THERAPY

Prigal [87] reviewed the development of aerosol therapy and the application of such therapy to clinical medicine. An adequate means and method of nebulizing various therapeutic agents was described, and the effect upon various diseases was presented. Mucolytics, spasmolytics, antibiotics, hormones, fungicides, antihistaminics, and miscellaneous oils can be administered by this method.

Doerner and co-workers [88] studied the effect of inhalation cortisone therapy of bronchial asthma in three patients and concluded that no benefit could be attributed to the medication.

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83. Cohen, B.: Bronchography by Crico-Thyroid Puncture, J. Laryng. & Otol. **66**:576 (Nov.) 1952.

84. Hentel, W.; Cohen, M. B., and Bradenstein, L. C.: Evaluation of Ioduron B in Bronchography: I. A Preliminary Study on Animal Tissues, Dis. Chest **21**:280 (March) 1952.

85. Cohen, M. B.; Hentel, W., and Bradenstein, L. C.: Evaluation of Ioduron B in Bronchography: II. A Preliminary Study in Man, Dis. Chest **21**:286 (March) 1952.

86. Rogers, J. V., and Weems, H. S.: Use of Water Soluble Contrast Media for Bronchography, Ann. Surg. **136**:971 (Dec.) 1952.

87. Prigal, S. J.: Studies with Steam Generated Aerosols: The Clinical Application of Antispasmodics, Mucolytics, Antibiotics and Other Agents in a Variety of Sino-Respiratory Diseases, Ann. Otol. Rhin. & Laryng. **61**:206 (March) 1952.

88. Doerner, A. A.; Naegele, C. F.; Regen, F. D., and Weingarten, W.: Inhalation Cortisone Therapy in Bronchial Asthma, Dis. Chest **21**:51 (Jan.) 1952.

Dye inhalation in the treatment of bronchopulmonary moniliasis was used by Kass and his co-workers.[89] Brilliant green was given by aerosol inhalation in 0.1% solution, 2 cc. being used five times daily. The strength was later increased to 0.3%. No toxic effects were noted, and excellent results were obtained.

Currence [90] reported improvement of purulent bronchiectasis due to Pseudomonas aeruginosa by treatment with acetic acid aerosol.

To secure lysis of respiratory secretions Limber and co-workers [91] administered the enzyme trypsin by aerosol. Crystalline trypsin with a pH of 7.1 in a concentration of 100,000 units per cubic centimeter was atomized, oxygen being used at a rate of 5 to 6 liters a minute. The initial dose was 50,000 units administered slowly, the amount was increased daily until the airways were clean and clear, and then the interval was prolonged as needed. The Vaponephrine type of nebulizer as used in penicillin aerosol administration was preferred. To prevent reactions of dyspnea, chills, or fever, 50 mg. of diphenhydramine hydrochloride or 10 grains of aspirin was given 20 minutes prior to the aerosol treatment. This method was used in the treatment of atelectasis, bronchiectasis, and ulcerative tuberculosis.

MIDDLE LOBE SYNDROME

An analysis of 19 cases of middle lobe syndrome was made by Fretheim.[92] Frequent colds, chronic cough, and hemoptysis were the chief clinical manifestations. Bronchoscopy revealed stenosis of the orifice of the middle lobe bronchus in only four cases, while congestion and edema of the mucous membrane about the middle lobe orifice was found in seven. In the remaining cases bronchoscopy gave negative results, and biopsy and cytologic examination in no instance proved the presence of tuberculosis or neoplasm. Bronchoscopy is important to rule out bronchogenic carcinoma rather than to verify the diagnosis of middle lobe syndrome.

CHRONIC BRONCHOPULMONARY DISEASES

Davison [93] considered the behavior of the tissues of allergic persons in response to infections to be different from the response of nonallergic persons to similar insults. Management of patients having bacterial allergy includes elimination of all foci of infection by surgery. When this has been accomplished, bactericidal doses of penicillin combined with the usual antiasthmatic measures frequently clear up the pulmonary infection. Bronchoscopic examination is of value for both diagnosis and treatment, and it focuses attention on infectious bronchitis, which is apt to be minimized in allergic patients.

Williams [94] reported a case of localized pulmonary hypertrophic emphysema in an infant in which the diagnosis of obstructive emphysema was made. Bronchoscopic

89. Kass, I.; Sasano, K. T., and Klein, W. S.: Treatment of Broncho-Pulmonary Moniliasis by Dye Inhalation, Dis. Chest **21**:205 (Feb.) 1952.

90. Currence, W. W.: Acetic Acid Aerosol Treatment of Purulent Bronchiectasis Due to Pseudomonas Aeruginosa, A. M. A. Am. J. Dis. Child. **83**:637 (May) 1952.

91. Limber, C. R.; Reiser, H. G.; Roettig, L. C., and Curtis, G. M.: Enzymatic Lysis of Respiratory Secretions by Aerosol Trypsin, J. A. M. A. **149**:816 (June 28) 1952.

92. Fretheim, B.: The So-Called Middle Lobe Syndrome, Thorax **7**:156 (June) 1952.

93. Davison, F. W.: The Allergic Factor in Chronic Bronchopulmonary Infections, Tr. Am. Acad. Ophth. & Otolaryng. **56**:206 (March-April) 1952.

94. Williams, M. H.: Localized Pulmonary Hypertrophic Emphysema, J. Thoracic Surg. **24**:522 (Nov.) 1952.

examination ruled out the presence of a foreign body and indicated diffuse inflammatory change in the tracheobronchial tree. Recovery followed operative removal of the involved lobe.

Eight cases of unilateral massive density in the lung due to chronic pneumonitis in which bronchogenic carcinoma was suspected were reported by Kergin.[95] The fundamental pathology in this group consisted of complete or partial bronchial obstruction by pressure of lymph nodes, which was the seat of a chronic inflammatory reaction secondary to silicosis. In three of the eight cases there was also tuberculous infection.

CARCINOMA IN SITU

Black and Ackerman [96] reviewed the microscopic sections in 60 cases of epidermoid and undifferentiated carcinoma of the lung removed at operation and found unquestionable carcinoma in situ in 13 and anaplastic hyperactivity of the intact bronchial epithelium in 8 others. If epidermoid carcinoma in situ is found on bronchoscopic biopsy, three possibilities were suggested: (1) the biopsy section represents an isolated single area of early cancer, (2) it is one of several similar areas of intraepithelial cancer, and (3) the in situ carcinoma lies next to an invasive carcinoma. When the clinical factors, such as history, radiological findings, and gross bronchoscopic appearance, favor frank, invasive carcinoma, an exploratory thoracotomy should be done without further confirmatory evidence. In cases in which the biopsy reveals considerable basal cell hyperactivity and anaplasia, strong suspicion that a carcinoma is present should be entertained and renewed efforts made to demonstrate its presence. In such cases cytologic examination of bronchial secretion and sputum has proved of great value. Of 13 cases of epidermoid carcinoma in situ a positive cytologic diagnosis was made in 10, in 2 the findings were highly suspicious, and in one the results were negative.

A case of bronchogenic epidermoid carcinoma in situ, arising in an area of squamous metaplasia and diagnosed by bronchoscopic biopsy and cytologic examination of bronchial secretions was recorded by Umiker and Storey.[97] Bronchoscopy revealed a small, granular, thickened area at the edge of the spur separating the lateral and posterior basal segments of the right lower lobe. The histologic report of tissue removed from this area was noninfiltrating and noncornifying carcinoma. Microscopic examination of the surgically removed right lower lobe revealed the thickened squamous metaplasia to contain carcinoma in situ with no invasion of the stroma at any point.

Williams [98] reported a case of extensive intraepithelial carcinoma in the mucosa of both major bronchi, the trachea, and the tertiary bronchi of the right lower lobe, in association with two invasive bronchogenic carcinomas.

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95. Kergin, F. G.: Silicotic and Tuberculosilicotic Lesions Simulating Bronchogenic Carcinoma, J. Thoracic Surg. **24**:545 (Dec.) 1952.

96. Black, H., and Ackerman, L. D.: Importance of Epidermoid Carcinoma in Situ in Histogenesis of Carcinoma of Lung, Ann. Surg. **136**:44 (July) 1952.

97. Umiker, W., and Storey, C.: Bronchogenic Carcinoma in Situ, Cancer **5**:369 (March) 1952.

98. Williams, M. J.: Extensive Carcinoma in Situ in the Bronchial Mucosa Associated with Two Invasive Bronchogenic Carcinomas, Cancer **5**:740 (July) 1952.

CYTOLOGY

Foot [99] demonstrated that cytologic examination makes possible not only the detection of malignant pulmonary tumors but also an estimate as to the type of new growth involved. In a series of 341 cases of pulmonary cancer, the type of pulmonary cancer was determined accurately by cytologic examination in 80%. The cytologic diagnosis was accurate for 89.9% of the epidermoid carcinomas, 69.2% of the pleomorphic carcinomas, 81.4% of all adenocarcinomas, and 83.5% of the anaplastic carcinomas. Smears of sputum provided better evidence for the recognition of the various types than did bronchial aspirates.

Schaaf and Suchowsky [100] analyzed the aid given by cytologic study in the diagnosis of bronchial carcinoma. Material withdrawn from the bronchial tree was used and proved far superior for examination to sputum, but the extremely high percentage of correctness of cytologic diagnoses was regarded with skepticism. The presence of atypical cells did not permit a definite diagnosis of bronchial carcinoma, nor was the absence of such cells regarded as definitely ruling out the existence of bronchogenic carcinoma.

Panico [101] used an abrasive balloon in the esophagus to obtain material for cytologic examination in two patients with squamous cell carcinoma. Although not enough is yet known about esophageal cytology for a diagnosis of the type of benign or malignant lesion to be made on the basis of the smear findings, the epithelial cell may reflect pathologic conditions of the esophageal mucosa.

BRONCHIAL ADENOMA

McBurney and his co-workers [102] studied 102 cases of bronchial adenoma and emphasized that far more patients with bronchial adenoma have died as a result of suppurative pulmonary disease than have died from metastasis of the adenoma. While antibiotics were found to control many of the septic manifestations of pneumonitis, they did not prevent the changes in the lung which resulted from bronchial obstruction. Only about 10% of bronchial adenomas were found to be located peripherally and to produce few or no pneumonitic changes in the lung. The degree of obstructive pneumonitis appeared to be directly related to the duration and degree of bronchial obstruction. With the relatively benign or low grade malignant adenomas, the incidence of pneumonitis and suppuration was highest for those patients in whom the obstruction had been present longer and was located in a central bronchus. In some cases of severe suppuration in patients who did not undergo resection, removal of bronchial obstruction by endoscopic means caused relief of symptoms and apparent healing, but with recurrence of obstruction severe pneumonitis recurred. Exclusive of the postoperative deaths, two patients died apparently as the result of multiple metastatic growths from the bronchial adenoma, and seven died of pulmonary suppuration and its effects.

99. Foot, N. C.: Identification of Types of Pulmonary Cancer in Cytologic Smears, Am. J. Path. **28**:963 (Nov.) 1952.

100. Schaaf, J. H., and Suchowsky, G.: Cytologic Studies as Aid in Diagnosis of Bronchial Carcinoma, Fortschr. Geb. Röntgenstrahlen **76**:711 (June) 1952.

101. Panico, F. G.: Cytologic Patterns in Benign and Malignant Gastric and Esophageal Lesions, Surg. Gynec. & Obst. **94**:733 (June) 1952.

102. McBurney, R. B.: Clagett, O. T., and McDonald, J. R.: Obstructive Pneumonitis Secondary to Bronchial Adenoma, J. Thoracic Surg. **24**:411 (Oct.) 1952.

Extensive microscopic studies were carried out by Delarue and his associates [103] on bronchial adenomas, which were considered to be epitheliomas with altered stroma similar to tumors that commonly arise in the salivary glands. The low degree of malignancy of these tumors was found to parallel the alterations of the stroma, being responsible for the slow course and the tendency to local growth, with nearly complete absence of distant metastasis. The tendency to local extension was illustrated in the case of a man who died four months after the appearance of the first symptom. The rapidly fatal course was due to the involvement of a pulmonary vein by a bud of the tumor, but there was no lymph node or visceral metastasis.

In discussing 14 cases of mixed tumor of the lung, Ehrenhaft and Womack [104] pointed out that designation of the tumor as adenoma is misleading, since it is an invasive lesion which can and does metastasize and, at times, is not purely epithelial in origin. The average age of the patients was somewhat younger than that of patients with squamous carcinoma of the bronchus. Whereas squamous carcinoma is observed chiefly in men, mixed tumors seem to be somewhat more frequent in women. When a major bronchus is involved the instillation of iodized oil generally shows occlusion, and bronchoscopic verification of the tumor is usually possible. Examination of the sputum and bronchial secretion for tumor cells has been disappointing. Since these tumors possess invasive characteristics with a tendency to metatasize, they should be considered malignant growths in spite of the fact that many of them will persist for many years without dissemination. They are composed of a mixture of different functioning tissues, and it was suggested that they result from a failure of proper tissue coordination in pulmonary development.

Wolcott [105] cited two cases of bronchial adenoma in which the operative findings were similar but the symptoms and history very dissimilar. The variation in the symptoms was dependent upon the endobronchial and peribronchial extension of the growth, with the resulting mechanical obstructions. It was thought that these tumors were so malignant that total extirpation was the best form of treatment. A definitely pedunculated tumor can be removed bronchoscopically, but one must always consider that a portion of the tumor may be peribronchial and cannot be removed by bronchoscopic means. Since the mucosa over these tumors is usually intact, cytologic study of the bronchial secretions commonly gives negative results. Bronchial adenomas were thought to be potentially malignant tumors, but the malignancy is low grade.

A case of peripherally located bronchial adenoma with histologic evidence of transformation into adenocarcinoma six years after its detection was described by Umiker and Storey.[106] A remarkable feature of this case was the apparent origin of the adenoma from multiple foci in the bronchial epithelium. Since the lesion was peripherally located, it suggested pulmonary tuberculosis until six years later, when central cavitation and necrosis developed, and subsequent surgical treatment uncovered the adenocarcinoma.

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103. Delarue, J.; Depierre, R., and Paillas, J.: Bronchial Adenomas or Epitheliomas with Altered Stroma: Identification of Bronchial Tumor with Myoepithelial Cells, Presse méd. **60**:469 (April 2) 1952.

104. Ehrenhaft, J. L., and Womack, N. A.: Mixed Tumors of Lung: A Re-Appraisal, Ann. Surg. **136**:90 (July) 1952.

105. Wolcott, C. C.: Bronchial Adenoma, Laryngoscope **62**:1225 (Nov.) 1952.

106. Umiker, W., and Storey, C. F.: Adenocarcinoma Developing in a Peripheral Bronchial Adenoma, J. Thoracic Surg. **24**:420 (Oct.) 1952.

Reid [107] separated bronchial adenomas into distinct histologic entities and reported five cases of adenoid cystic carcinoma of the bronchial tree. This type had a long clinical course and frequently involved the trachea. Its moderately high malignant tendency was evidenced by its pronounced infiltrative tendencies and the occurrence of distant metastases in one-fourth of the reported cases.

Bradshaw and his associates [108] reported a case of bronchial adenoma that recurred eight years after pneumonectomy. The long quiescent period indicated the slow rate of growth of the tumor but did not detract from its malignant nature. It was thought that the name mixed-tumor adenoma was more suitable than adenoma when applied to such neoplasms of the bronchus.

BRONCHIAL NEOPLASMS

According to Moersch and his associates,[109] who studied 35 surgically proved cases of hamartoma of the lung, the tumor occurs twice as often in men as in women and is most frequently seen in middle age. In three patients the tumor was located within the lumen of the bronchus, and in two of these three the tumor was removed by means of bronchoscopy. In one-half of the patients the tumor was asymptomatic. Pulmonary symptoms depended largely on the size and location of the tumor, and tumors near the hilus or impinging upon the bronchial lumen more often produced symptoms than those situated peripherally. In almost 60% of the patients roentgenologic findings provided the only clue to the presence of the lesion. Since these tumors seldom, if ever, become malignant they can be removed by bronchoscopic means or treated nonsurgically, provided the diagnosis can be made before exploratory thoracotomy. Surgical treatment becomes necessary when differentiation clinically or roentgenologically from a malignant tumor cannot be made.

Three cases in which fibrosarcoma of the bronchus was diagnosed by bronchoscopic biopsy were reported by Storey.[110] Two of the three fibrosarcomas were considered definitely to have arisen primarily in a bronchus. The lesion in the third case involved a major bronchus, as proved by bronchial biopsy, but at the time of thoracotomy the exact site of origin of the huge tumor could not be determined with certainty, although a primary bronchial origin was considered most probable. Only seven previously reported cases of primary bronchial fibrosarcoma diagnosed by bronchoscopic biopsy could be found in the literature, to which seven the author's three cases were added. The treatment advocated in all cases was pulmonary resection.

Cooper and Pecora [111] reported two cases of pulmonary hamartoma and stated that the only treatment of this type of lesion is surgery. If surgery is not accomplished, an early malignant lesion may be overlooked.

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107. Reid, J. D.: Adenoid Cystic Carcinoma (Cylindroma) of Bronchial Tree, Cancer **5**:685 (July) 1952.

108. Bradshaw, H. H.; Shaffner, L. S., and Deaton, W. R., Jr.: Bronchial Adenoma, J. Thoracic Surg. **23**:388 (April) 1952.

109. Moersch, H. J.; Donoghue, F. E., and McDonald, J. R.: Hamartoma of the Lung, Quart. Rev. Surg. Obst. & Gynec. **9**:191 (Dec.) 1952.

110. Storey, C. F.: Fibrosarcoma of the Bronchus: Report of 3 Cases Diagnosed by Bronchoscopy and Treated by Resection, J. Thoracic Surg. **24**:16 (July) 1952.

111. Cooper, P., and Pecora, D. V.: Pulmonary Hamartoma: With Case Reports, Rhode Island M. J. **35**:368 (July) 1952.

Two cases of endobronchial carcinosarcoma were reported by Taylor and Rae.[112] The tumors were considered true carcinosarcomas rather than squamous cell carcinomas with change to a spindle cell variant. One of the patients died of a massive hemorrhage after bronchoscopic biopsy. Such tumors appear to offer a better prognosis than bronchogenic carcinoma.

A case of benign fibroma of the lung was presented by Crimm and Kiechle.[113] At bronchoscopy the tumor was visualized in the left lower lobe bronchus, and biopsy revealed a benign fibroma. It was suggested that the tumor originated from the connective tissue of the bronchial wall and enlarged and extended into the lung by compression. No recurrence was noted 18 months after removal of the tumor and excision of the left lower lobe.

A case of solitary plasma cell plasmocytoma of the lung was reported by Cotton and Penido.[114] The only abnormality observed on bronchoscopic examination was an extrinsic pressure on the lateral portion of the left main bronchus at the level of and just below the orifice of the left upper lobe.

A case of lipoma of the bronchus diagnosed and treated endoscopically was reported by Beaton and Heatly.[115] On bronchoscopy a smooth rather pale-pink mass about 1.5 cm. in diameter was visualized approximately 2 cm. from the carina in the left main bronchus. It almost completely obstructed the lumen of the bronchus and seemed to be attached by a rather broad base to the floor and lateral wall. There was no suppuration distal to the tumor, and tissue removed for histologic examination revealed a true lipoma. Since there was no peribronchial extension, endoscopic treatment was used, with removal of the tumor and coagulation of the base. Follow-up over several months demonstrated no recurrence of the tumor and no abnormality in the bronchus. The possible etiology was suggested by a series of microscopic sections on 10 lungs. In every instance fat was found in the submucosal tissues of the tracheobronchial tree extending peripherally to the limits of the cartilage, always in close association with the cartilage. The more proximal specimens contained large quantities of fat, which were located primarily in the connective tissue interspaces and external to the cartilage. As more distal sections were obtained, the location became more variable, appearing around the glands and blood vessels as well as between the cartilaginous segments. Both submucosal and periglandular fat was demonstrable at every level.

A patient with alveolar cell carcinoma of the lung, which had been present for 11 years before death, was described by White and his co-workers.[116] The symptoms were attributed to unresolved pneumonia.

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112. Taylor, H. E., and Rae, M. V.: Endobronchial Carcinosarcoma, J. Thoracic Surg. **24**:93 (July) 1952.

113. Crimm, P. D., and Kiechle, F. L.: Fibroma of the Lung, J. Thoracic Surg. **23**:205 (Feb.) 1952.

114. Cotton, B. H., and Penido, J. R. F.: Plasma Cell Tumors of the Lung: Report of a Case, Dis. Chest **21**:218 (Feb.) 1952.

115. Beaton, A. H., and Heatly, C. A.: Fat in the Tracheobronchial Tree with Report of a Case of True Lipoma of the Bronchus, Ann. Otol. Rhin. & Laryng. **61**:1206 (Dec.) 1952.

116. White, J. N.; Madding, G. F., and Hershberger, L. R.: Alveolar Cell Tumor of the Lung, Dis. Chest **21**:655 (June) 1952.

BRONCHOGENIC CARCINOMA

McGrath and co-workers [117] examined 87 lungs containing bronchogenic carcinoma, and the findings lend weight to the hypothesis that bronchogenic carcinoma may often arise from more than one site and that frequently the clinical diagnosis is not made until coalescence of independent growths has been completed. In five of the lungs there were two grossly visible primary carcinomas in the same or different lobes. In 25 others there was found, on microscopic examination, preinvasive or early invasive carcinoma either in close contiguity with the main tumor or at such a distance from it as to be considered an independent lesion. In over half of the cases the major tumor contained two to five different histologic patterns arranged in such a manner as to imply initial independence and ultimate fusion.

Clerf and Herbut [118] considered the two most important items in the early diagnosis of carcinoma of the lung to be a high index of suspicion and a determination to carry out the various diagnostic procedures without delay. From a clinical standpoint, the following factors should be considered: cough, expectoration, pain, discomfort, dyspnea, wheezing respiration, abnormal pulmonary shadows in roentgenograms, and bronchoscopy. From a pathologic viewpoint, bronchial biopsy and/or cytologic examinations of bronchial secretions and sputum are mandatory. If a positive preoperative morphological diagnosis cannot be made and the possibility of carcinoma cannot be excluded clinically, exploratory thoracotomy is indicated.

Seventy consecutive patients with bronchogenic carcinoma were studied by Reiss and associates.[119] The diagnosis was made on direct inspection through the bronchoscope in 25 cases, in 10 of which bronchial biopsy established the diagnosis, and in 8 instances neoplastic cells were found on cytologic examination of the bronchial secretions. In four of the latter group no tumor tissue was visible. Of the 20 patients operated on, 10 were found to have resectable lesions, but only 5 were still alive with a chance of cure.

Imprescia [120] believes that chromates are carcinogenic and to substantiate this contention cited seven cases of bronchogenic carcinoma in persons exposed to chromates in industrial work. The duration and extent of exposure were considered significant factors.

Gittens and Mihaly [121] discussed primary carcinoma of the lung in 28 proved cases observed in a five-year period. In 14 cases the lesion was diagnosed by bronchoscopic biopsy, in 4 cases by exploratory thoracotomy, in 3 cases by lymph node biopsy, and 1 case by aspiration biopsy of the lung and cytologic examination of bronchial secretions. In the other cases it was diagnosed at autopsy.

117. McGrath, E. J.; Gall, E. A., and Kessler, D. P.: Bronchiogenic Carcinoma: A Product of Multiple Sites of Origin, J. Thoracic Surg. **24**:271 (Sept.) 1952.

118. Clerf, L. H., and Herbut, P. A.: Early Diagnosis of Carcinoma of the Lung, J. A. M. A. **150**:793 (Oct. 25) 1952.

119. Reiss, J.; Baum, G. L., and Kovnat, M.: The Early Recognition and Treatment of Bronchogenic Carcinoma, Dis. Chest **22**:529 (Nov.) 1952.

120. Imprescia, S.: Bronchogenic Carcinoma and Chromates, Dis. Chest **22**:347 (Sept.) 1952.

121. Gittens, S. A., and Mihaly, J. P.: Primary Carcinoma of the Lung, Dis. Chest **21**:641 (June) 1952.

Angiocardiographic studies will probably become a preoperative procedure prior to any lung surgery for cancer. Steinberg and Dotter [122] discussed their findings in 100 consecutive cases of lung cancer. Vascular changes occurred in 87% of the cases. In 43% there was vascular evidence pointing to probable inoperability.

In a series of 160 patients with bronchial carcinoma Huizinga [123] obtained positive results from biopsy in 80%. This high percentage was due to what was termed directed bronchoscopy. On the grounds of localization by roentgen examination, including planigraphy and bronchography, a certain bronchus was suspected of being the seat of the trouble. On bronchoscopy this bronchus or subdivision was aimed at, and tissue was blindly removed by means of a curette. This form of blind removal of a biopsy specimen was done with a small curette, and the greatest difficulty was encountered when the localization was in the upper lobe or toward the periphery of the middle and lower lobes. Bronchography was performed prior to bronchoscopy for two reasons: (1) to localize the involved bronchus so that directed bronchoscopy could be performed and (2) to show various anomalies that are sometimes of great importance in determining operability. The diagnosis by this means was made in 17 of 123 cases. The bronchial cytologic method is now being used, but the fact was emphasized that in this method, too, it is necessary to perform directed bronchoscopy in order to remove secretion from the involved bronchus. Considerable bronchial stenosis may exist, but this may not be evident on the roentgenograms because of colateral ventilation.

Baldry [124] reported nine instances of carcinoma arising from the middle lobe bronchus in cases of "middle lobe syndrome." These cases simulated those due to other diseases, including lung abscess, interlobar empyema, and postinfective bronchostenosis. Bronchoscopy in such cases is not always helpful and at times is misleading. One source of error was the presence of abnormal tissue which on biopsy proved to be granulation tissue suggesting a primary inflammatory process, whereas the inflammation was secondary to a distal carcinoma.

A case of squamous cell carcinoma arising in a bronchiectatic cavity was presented by Konwaler and Reingold.[125] The diagnosis was made by recovery of neoplastic cells from the bronchoscopically removed secretions.

A series of 501 proved cases of bronchogenic carcinoma was reported by Lea.[126] Bronchoscopy was performed in 288 cases. In 92.7% of those cases in which bronchoscopy was carried out, some form of bronchial abnormality was found, although this was not always recognized as carcinoma until the reports of the biopsy had been received. In 7.3% bronchoscopy failed to reveal any abnormality. Of those cases in which biopsy was performed, it failed to show evidence of malignancy in only 3.2%.

Allbritten and his associates [127] reported 405 consecutive cases of bronchogenic carcinoma, among which a positive tissue diagnosis was obtained in 24.4% and a

122. Steinberg, L., and Dotter, C. T.: Lung Cancer: Angiocardiographic Findings in 100 Consecutive Proved Cases, A. M. A. Arch. Surg. **64**:10 (Jan.) 1952.

123. Huizinga, E.: Bronchography in Bronchial Cancer and Collateral Ventilation, J. Thoracic Surg. **23**:445 (May) 1952.

124. Baldry, P. E.: Carcinoma of the Middle Lobe, Thorax **7**:240 (Sept.) 1952.

125. Konwaler, B. E., and Reingold, I. M.: Carcinoma Arising in Bronchiectatic Cavities, Cancer **5**:525 (May) 1952.

126. Lea, A. J.: A Survey of 501 Cases of Bronchogenic Carcinoma, Thorax **7**:305 (Dec.) 1952.

127. Allbritten, F. F., Jr.; Nealon, T.; Gibbon, J. H., Jr., and Templeton, J. Y., III: The Diagnosis of Lung Cancer, Surg. Clin. North America **32**:1657 (Dec.) 1952.

positive cytologic diagnosis in an additional 54.2%. Despite this high percentage of positive diagnoses, 29% of the group had obvious metastasis when first seen, 31% had sufficient spread beyond the confines of the lung to prevent removal of the primary lesion, and only 49% had a resectable growth. Earlier diagnosis is necessary to salvage a greater number of patients with lung cancer.

Aufses and Neuhof [128] reported a follow-up study on two patients in whom resectional lung surgery had been performed on the basis of a microscopic diagnosis of pulmonary carcinoma made on examination of a specimen removed at bronchoscopy. No carcinoma was found in the resected lung on one patient, who had a pneumonectomy, and he remained well for over six years. At operation on the second patient no gross tumor was seen and bronchoscopy during the operation and subsequently revealed no evidence of disease; therefore, only a middle lobe lobectomy was performed. In the second case bronchoscopy five years later revealed a carcinoma in the main bronchus on the side previously operated upon. It was concluded that the thoracic surgeon, in determining surgical treatment, must rely upon the pathologist's diagnosis made on the microscopic examination of specimens removed during bronchoscopy.

BRONCHOGENIC CARCINOMA AND PULMONARY TUBERCULOSIS

The value of bronchoscopy for tuberculous patients was emphasized by Goldberg and co-workers.[129] Whenever atypical findings are present in tuberculous patients, bronchoscopy and cytologic study of bronchial secretions should be used to complete the diagnosis. Five cases of active pulmonary tuberculosis in association with bronchogenic carcinoma were reported.

ACQUIRED FISTULA BETWEEN AIR AND FOOD PASSAGES

Mellins [130] presented a case of acquired fistula between the esophagus and the lung and stated that the main causes of acquired tracheoesophageal fistula in the order of frequency are carcinoma, trauma, syphilis, and tuberculosis. The commonest site is the region of the bifurcation of the trachea.

ESOPHAGOLOGY

Norris [131] reviewed the general plan of diagnostic procedures in the study of suspected esophageal disease and discussed the clinical features of the commoner diseases. Properly conducted roentgen study and confirmatory diagnosis by means of direct examination were stressed.

Fry and Putney [132] emphasized the importance of symptoms in the diagnosis of benign lesions of the esophagus. Even though either roentgen or esophagoscopic

128. Aufses, A. H., and Neuhof, H.: Minute Carcinoma of the Major Bronchi, J. Thoracic Surg. **23**:219 (March) 1952.

129. Goldberg, J.; Figueras, E. R., and Barshay, B.: Coexistent Bronchogenic Carcinoma and Active Pulmonary Tuberculosis: A Report of 5 Cases with Autopsy Findings, Dis. Chest **21**:184 (Feb.) 1952.

130. Mellins, R. B.: Acquired Fistula Between the Esophagus and the Respiratory Tract, New England J. Med. **246**:896 (June 5) 1952.

131. Norris, C. M.: Diagnosis of Diseases of the Esophagus, Pennsylvania M. J. **55**:30 (Jan.) 1952.

132. Fry, K. E., and Putney, F. J.: The Diagnosis of Benign Lesions of the Esophagus, S. Clin. North America **32**:1645 (Dec.) 1952.

findings alone seemed conclusive, the other study was necessary, for the additional information confirmed, supplemented, or, occasionally, altered the previous diagnosis. Most benign esophageal lesions were discovered by these procedures, but the differentiation between a benign and a malignant lesion was not always possible, and surgical excision was required to establish a final diagnosis in some cases.

DYSPHAGIA

Asherson [133] described three cases of compression dysphagia produced by aberrant great vessels in the upper third of the esophagus. Vascular abnormalities have been detected and diagnosed during life more frequently because of the modern technique of chest and heart radiography. In infancy the vascular abnormalities may produce difficulty in swallowing, which becomes more pronounced as the infant grows older. There are discomfort on swallowing, slowness in feeding, and the taking of only small amounts at one time. Vomiting may be absent or intermittent and chiefly noted when the infant begins to take solid food. The respiratory symptoms may largely overshadow the dysphagia, resulting in an erroneous diagnosis. The main respiratory symptoms are stridor soon after birth and a persistent cough. The syndrome of dysphagia lusoria was described as developing late in life, at or near the menopause. On the roentgenograms of patients with this syndrome there was observed lipping of the adjacent surfaces of the fifth and sixth cervical vertebrae. Here the pharyngoesophagus is anchored to the prevertebral fascia and ligaments. It was postulated that an adhesion due to infection formed here and that as the pharynx was elevated with each act of swallowing the traction produced by the adhesion manifested itself by a slight dysphagia. Esophagoscopy was found to give relief. Another observation on adults was that excessive calcification of the posterior plate of the cricoid cartilage gave rise to a vague dysphagia in several middle-aged women.

McMahon [134] recognized that the esophagus is often the site of reactions to emotional factors. Dysphagia and esophageal pain were found to be commonly functional in origin, and proper treatment involved attention to both the psychic and the somatic factors involved. The three main functional causes of dysphagia were (1) globus hystericus, (2) diffuse spasm of the esophagus, and (3) cardiospasm.

ESOPHAGEAL SPASM

Klein [135] discussed globus hystericus and tension states, with emphasis on symptoms in the esophagus. Even though there was definite increased tension resulting in symptoms of dysphagia, there were completely negative x-ray and esophagoscopic findings. The tenseness of the esophagus was considered to be the result of parasympathetic stimulation, while cardiospasm was thought to be adrenergic.

Ismay [136] called attention to the uncommon condition of "corkscrew" esophagus and reported one case. The term curling of the esophagus has also been used in

133. Asherson, N.: Dysphagia Lusoria: With a Record of 3 Cases, J. Laryng. & Otol. **66**:111 (March) 1952.

134. McMahon, J. M.: Functional Causes of Dysphagia, Am. Pract. & Digest Treat. **3**:744 (Sept.) 1952.

135. Klein, H.: Functional Tense Esophagus and Esophageal Spasm, Rev. Gastroenterol. **19**:861 (Nov.) 1952.

136. Ismay, G.: Painful Spasm of the Esophagus ("Corkscrew" Esophagus), Brit. M. J. **2**:697 (Sept. 27) 1952.

describing the alternating contractions and dilatations of the esophagus below the level of the aortic arch due to multiple segmental spasms. These spontaneous spasms do not always encircle the esophagus but may occur anteriorly, laterally, or posteriorly. The esophagus may become partially or completely occluded by the spasms, and stasis develops. The chief symptoms are pain on swallowing or concomitant with the spasms, progressive dysphagia, and regurgitation. The etiology was attributed to degenerative changes in Auerbach's plexus as a result of arteriosclerosis. Antispasmodic drugs were helpful in treatment, and amphetamine produced more lasting relief.

PAIN FROM ESOPHAGEAL DISEASE

Pain resembling angina pectoris may be due in some cases to esophageal arrhythmia, as explained by Evans.[137] This disturbance of the normal progression of esophageal peristalsis is temporarily arrested at the hiatus, with intermittent reverse peristalsis. This condition was found in 40% of 332 patients who had pain resembling cardiac pain and who had normal electrocardiograms.

VAGOTOMIZED ESOPHAGUS

Donald[138] studied esophageal dysfunction in the rat after vagotomy and noted that dilatation of the esophagus, especially the thoracic portion, and regurgitation and retention of food resulted. Interference with the normal progression of food down the esophagus occurred, and operations designed to render the cardia more patent were found to increase the severity of the symptoms which followed vagal section.

PEMPHIGUS OF ESOPHAGUS

Benedict and Lever[139] described the esophageal lesions in benign mucous membrane pemphigus and reported four cases. The esophageal findings consisted of diffuse inflammation of the mucosa and the submucosa but no bullae. The reason no bullae were found may have been the fact that the examination of the esophagus was carried out in cases of long standing and bulla formation had been superseded by scarring. The scarring in the esophagus leads to soft adhesions which have the esophagoscopic appearance of webs. They differ from other esophageal webs in being fine, thread-like adhesions resembling cobwebs running vertically, obliquely, or transversely. These adhesions are thin and soft at first but later become firmer. The recognition of esophageal involvement in benign mucous membrane pemphigus is important, because the soft adhesions in the early stage can easily be divulsed, whereas the adhesions in their late stage are resistant to treatment by bougienage. Since webs may not be demonstrable by x-ray, esophagoscopy should be performed regardless of the roentgen findings. Several esophagoscopies may be necessary to arrive at the correct diagnosis and later to dilate the stenosed esophagus. The possibility of the presence of more than one web should also be kept in mind.

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137. Evans, W.: Esophageal Contraction and Cardiac Pain, Lancet **2**:1091 (Dec. 6) 1952.

138. Donald, D. E.: Esophageal Dysfunction in the Rat After Vagotomy, Surgery **31**:251 (Feb.) 1952.

139. Benedict, E. B., and Lever, W. F.: Stenosis of the Esophagus in Benign Mucous Membrane Pemphigus, Ann. Otol. Rhin. & Laryng. **61**:1120 (Dec.) 1952.

ESOPHAGEAL BLEEDING

A group of 20 patients with upper esophagogastrointestinal bleeding were studied esophagoscopically by Desforges and associates.[140] Direct visualization of the esophagus excluded a diagnosis of bleeding varicosities in 10 patients. In one there was active arterial bleeding from an esophageal carcinoma, another presented friable mucosa due to chronic esophagitis in the lower third of the esophagus, and a third patient had some irregularity of the esophageal mucosa but no varices and no bleeding point. In nine patients varices were demonstrated, and active bleeding was found in four of these. The exclusion of esophageal varicosities or bleeding from an eroded area in a hiatal hernia helped establish a rationale for abdominal surgery. An esophagoscopic diagnosis of varices in cases of severe upper esophagogastrointestinal hemorrhage was sufficient for immediate balloon tamponage, whether or not a bleeding point was visualized.

ESOPHAGITIS

Hoover [141] reviewed 72 cases of esophagitis and emphasized the fact that there was marked variation in symptomatology, pathology, accompanying disease and nutritional state in each case studied. Approximately 60% of the patients with disabling esophagitis had hernias through the diaphragm, most commonly at the esophageal hiatus and associated with short esophagus. There were three cases of esophagitis caused by vomiting and increased intra-abdominal pressure associated with pregnancy. The indwelling Levin tube in the treatment of patients after abdominal operations was the related etiologic factor in four instances. In four cases of severe esophagitis there was a history of a perforated peptic ulcer. Debilitated states were found to predispose to esophagitis. Surgical excision of the esophagogastric junction was found to be an etiologic factor of great and increasing importance in the production of esophagitis. Substernal distress and various degrees of pain were nearly always present, and bleeding of a minor degree was common in this series. On esophagoscopic examination the esophagitis may be seen to extend over a considerable length of the esophagus. There was often found a thin membrane with a superficial ulceration, and at the edge of the membrane a red line or border could be seen. If the membrane over the ulceration was removed, bleeding resulted. In cases of short duration the induration of the esophageal wall might be slight, whereas in other cases the walls might be sufficiently indurated and thickened to produce narrowing and prevent the esophageal lumen from closing. Treatment including dilatation often was necessary before the strictured area could be passed and the esophagus visualized below this area. It was necessary to rule out carcinoma. Most of the patients responded well to medical treatment with dilatation. Most strictures could be controlled in a fairly satisfactory manner by appropriate dilatation when the patient was willing to carry out the recommended procedures. Long-continued dilatation was necessary when surgical treatment was not accepted or was contraindicated. Of the 72 patients, 28 resumed a normal life with slight dietary and positional restrictions. Twenty-three patients had to continue dilatations at intervals and follow dietary and medical management. Fourteen patients had no

140. Desforges, G.; Aves, F. H., and Strieder, J. W.: Esophagoscopy in Esophagogastrointestinal Hemorrhage, J. A. M. A. **149**:639 (June 14) 1952.

141. Hoover, W. B.: Esophagitis: A Clinical Evaluation, Ann. Otol. Rhin. & Laryng. **61**:1148 (Dec.) 1952.

improvement under treatment, and their esophagitis was still disabling. Seven deaths occurred, two as a result of perforation of the esophagus, two as a result of massive untreated hemorrhage, 3 postoperatively.

In a review of esophagitis Harman [142] recommended a wide endoscopic survey in cases of chest pain and heartburn to clarify views on the early pathologic changes of esophagitis.

Mason and Ausband [143] described a case of benign stenosing esophagitis associated with vomiting and intubation. The precursors of esophagitis in this case seemed to be intermittent vomiting, which had been present for years together with persistent acute vomiting following cholecystectomy and the use of an indwelling nasogastric tube. All these factors were conducive to the admission of gastric juice into the lower esophagus, which had appeared normal by roentgen study prior to operation. In treatment physiological rest and neutralization of acid pepsin were accomplished by gastrostomy with frequent feedings. Restoration of an adequate food passageway was obtained by dilatation, at first in a retrogade direction through the gastrostomy, and later, after the gastrostomy opening was allowed to close, bougienage was continued with Hurst dilators.

Of 65 patients who underwent esophagogastrostomy or cardioplasty, Ripley, Olsen, and Kirklin [144] found that 28 subsequently had positive signs and 12 had presumptive signs of peptic esophagitis or stricture. Almost without exception in patients having enough postoperative distress to warrant endoscopic examination, ulcerative peptic esophagitis or stricture or both existed. This study corroborated the fact that postoperative regurgitation of gastric juice can cause esophageal peptic inflammation. Postoperative esophagitis developed after each type of cardioplasty or esophageal resection employed in treating intractable cardiospasm except the Heller operation. Among persons who underwent postoperative esophagoscopy or tissue examination, 28 of 29 had positive signs of esophagitis or stricture. Among 36 persons not examined esophagoscopically, signs and symptoms of presumptive esophagitis or formation of stricture were found. Surgical procedures which interfere with the esophagogastric junction or bypass the cardiac mechanism result in disturbed function, allowing repeated regurgitation of gastric juice into the esophagus and thus giving rise to esophagitis. Although soon after operation the patients were relieved of esophageal obstruction and symptoms, after a latent period there developed progressive dysphagia and esophageal symptoms appeared.

FOREIGN BODIES IN THE ESOPHAGUS

Esophageal foreign bodies may cause respiratory symptoms in infants due to diminution in the tracheal diameter. Tompsett [145] advised lateral as well as posteroanterior roentgenograms, together with an esophageal study with contrast media to aid in the diagnosis.

142. Harman, J. B.: Esophagitis, Brit. M. J. **1**:941 (May 3) 1952.

143. Mason, L. B., and Ausband, J. R.: Benign Stenosing Esophagitis Associated with Vomiting and Intubation, Surgery **32**:10 (July) 1952.

144. Ripley, H. R.; Olsen, A. M., and Kirklin, J. W.: Esophagitis After Esophagogastric Anastomosis, Surgery **32**:1 (July) 1952.

145. Tompsett, A. C.: Respiratory Symptoms Due to Esophageal Foreign Bodies in Infants, Wisconsin M. J. **51**:481 (May) 1952.

Gants [146] reported a case of an esophageal foreign body consisting of a denture containing the upper two central incisors with a many-pronged clasp. It was lodged at the level of the seventh and eighth thoracic vertebrae. Repeated esophagoscopic examinations were unsuccessful in removing or dislodging the foreign body, and removal by esophagotomy was necessary.

An unusual foreign body that caused complete obstruction of the esophagus in its upper third in an elderly patient was reported by Belmont.[147] The foreign body consisted of a gelatinous mass formed from three coated methylcellulose tablets that became hydrated in the esophagus. The symptoms of choking and smothering, with inability to swallow, persisted until endoscopic removal of the gelatinous mass eight hours after its ingestion.

Robertson [148] reported a case of ulceration of the arytenoid and postcricoid region together with paralysis of the left vocal cord in a patient with preceding pulmonary tuberculosis, who also gave a history of swallowing a foregn body in the form of a corset steel five years previously. Little attention was paid to the foreign body history, and the ulceration was considered to be malignant or, alternatively, tuberculous, until autopsy revealed that the ulceration was inflammatory and nonspecific. It was then assumed that the trauma incident to the swallowing of the foreign body five years previously had produced the ulceration in the postcricoid region.

ESOPHAGEAL PERFORATIONS

Dugan [149] reported 16 esophageal perforations, 11 of which were caused by endoscopic trauma; 6 of these were cervical perforations and the remaining 5 lower esophageal penetrations. Of the 6 cervical tears, four were produced by esophagoscopy for diagnosis, and two were the result of penetrating foreign bodies in the cricopharyngeal area. In the four diagnostic esophagoscopies no difficulty was encountered in introduction of the instrument, so that direct penetration was considered unlikely. The total time consumed during each procedure averaged well over 35 minutes. All four revealed linear tears over the region of the sixth and seventh cervical vertebrae. The cause of the perforations was thought to be prolonged pressure of the body of the esophagoscope resting on the prominent sixth and seventh vertebrae. Treatment was cervical mediastinotomy and repair of the rent as soon as the diagnosis was made. In the two cases of penetrating foreign bodies in the upper esophagus, recovery followed supportive and antibiotic measures without surgery. Of the five instrumental lower esophageal perforations, two followed retching, gagging, and straining during the passage of the tube through the lower esophagus, and the remaining three followed dilatation therapy. In this group two healed with symptomatic and supportive treatment, one required drainage of a left empyema and the patient later died, and two patients recovered after late reparative surgical procedures.

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146. Gants, R. T.: Traumatizing Foreign Body in the Esophagus, U. S. Armed Forces M. J. **3**:473 (March) 1952.

147. Belmont, M. H.: Esophageal Obstruction Due to Methylcellulose, J. A. M. A. **148**:372 (Feb. 2) 1952.

148. Robertson, E. E.: Post-Cricoid Ulceration Following Ingestion of Foreign Body, J. Laryng. & Otol. **66**:327 (July) 1952.

149. Dugan, D. J.: The Management of Esophageal Perforations, Dis. Chest **22**:556 (Nov.) 1952.

Korkis [150] reported three cases of successfully treated mediastinitis due to foreign body perforation of the cervical esophagus.

ESOPHAGEAL STRICTURES

Krey [151] demonstrated experimentally that secondary infection is an important factor in the development of cicatricial strictures. The inflammatory changes produced granulation tissue, which was later transformed into sclerotic, contracting connective tissue. The extent and quantity of the granulation tissue determined the degree of stricture. When the esophagus was allowed to rest until epithelization was complete, mechanical irritation of the wound was avoided, and secondary infection was reduced to a minimum. The absence of the movements associated with swallowing probably results in limiting the inflammatory process, which in turn retards the development of a stricture. When the wound is covered with epithelium, the inflammation disappears, and the production of granulation and connective tissue stops. The experimental animals were divided into four series: The first received no treatment. The second series, treated with sulfonamides, penicillin, and streptomycin, exhibited a thickening of the esophageal wall at the site of the lesion, with roentgen evidence of stenosis after epithelization was completed. In the third group, treated with an indwelling tube, sulfonamides, penicillin, and streptomycin, the thickening of the esophageal wall was as great as in the untreated series, and the wound failed to epithelize. In the last series, treated with gastrostomy, sulfonamides, penicillin, and streptomycin epithelization was complete in 35 days, which was the shortest period in any group, and only moderate stenosis was observed on the roentgenogram. Thickening of the esophageal mucosa at the site of the lesion developed, but this was the only group in which the animals were able subsequently to feed.

Weisskopf [152] demonstrated the advantage of cortisone therapy in preventing stricture after lye burns of the dog's esophagus. Cortisone was given over a six week period in a dosage of 75 mg. a day, which approximates for the experimental animal the amount that would be given to the child. Oxytetracycline (Terramycin), 500 mg. a day, was used in conjunction with the cortisone therapy as a protection against overwhelming sepsis. Experimentally, cortisone therapy diminished the local inflammatory reaction and granulations, and no strictures developed in the treated group, whereas in all control animals living over 35 days a stricture developed. This method of treatment was used in the case of a 17-month-old boy with a severe lye burn without development of a stricture or other complications. Although cortisone therapy seems to aid in preventing stricture formation, further observation and study are needed.

A study of 47 cases of chemical burns of the esophagus which occurred over a 15-year period was made by Stothers.[153] The commonest cause of burns of the esophagus was ingestion of lye, which occurred chiefly in young children. Chemical

150. Korkis, F. B.: Mediastinitis Following Foreign Body Perforation of the Cervical Esophagus, Lancet **1**:4 (Jan. 5) 1952.

151. Krey, H.: On the Treatment of Corrosive Lesions in the Esophagus, Acta oto-laryng., Supp. 102 (March) 1952.

152. Weisskopf, A.: Effects of Cortisone on Experimental Lye Burn of the Esophagus, Ann. Otol. Rhin. & Laryng. **61**:681 (Sept.) 1952.

153. Stothers, H. H.: Chemical Burns and Strictures of the Esophagus, A. M. A. Arch. Otolaryng. **56**:262 (Sept.) 1952.

burns caused by agents other than lye were commoner in adults. The severity of the stricture depended upon the type, concentration, and amount of the corrosive agent that came in contact with the esophageal wall. No cases of complete cicatricial atresia were included in this group. The outstanding symptoms were pain low in the throat and substernal region, dysphagia, and fever. The diagnosis could often be determined by the history alone, but roentgenoscopic and esophagoscopic examinations were nearly always necessary for diagnostic purposes. Of the 47 patients, 3 died of shock or pulmonary edema within a 24-hour period. In the treatment of the acute lesions an attempt was made to neutralize the poison and to control shock and infection. To prevent stricture formation the Salzer method of early bougienage was advocated. The management of chronic strictures was considered under the orthodox bougienage methods and surgical repair of the esophagus, although no patients in the report had esophageal surgery.

LESIONS OF LOWER ESOPHAGUS

Moersch [154] stressed the difficulties experienced in the differential diagnosis of lesions involving the lower portion of the esophagus. The esophagologist's role is important in establishing a diagnosis. Cardiospasm may assume a variety of forms varying from slight obstruction at the cardia with minimal dilatation of the esophagus to marked obstruction at the cardia with enormous dilatation and angulation of the esophagus above. When the obstruction is firm or hard the possibility of neoplasm must be seriously considered. The esophagoscopic findings vary with the degree and duration of the esophageal obstruction. If extreme angulation occurs in the lower end of the esophagus, some difficulty may be experienced in passing the esophagoscope through the cardia and into the stomach, and the correctness of the diagnosis may be doubtful. Diffuse spasm of the lower third of the esophagus is frequently confused with cardiospasm. Its symptoms closely resemble those of cardiospasm, but on roentgenologic examination there is evidence of diffuse spasm involving the lower third of the esophagus, usually associated with slight dilatation of the upper two-thirds. The esophagoscopic findings vary according to whether the examination is performed with the patient under topical or under general anesthesia. With general anesthesia nothing except a mild degree of esophagitis may be encountered. With local anesthesia the lower third of the esophagus will be found closed and the obstruction can usually be overcome gradually by applying gentle pressure with the instrument as it is advanced. On passage of a sound over a previously swallowed silk thread, the obstruction encountered in the lower portion of the esophagus will give way under gentle pressure and the sound will advance slowly through the esophagus, although it will be grasped repeatedly by the esophageal spasm. Congenital anomalies of the lower portion of the esophagus, esophageal varices, esophagitis, tuberculosis, fungus diseases, and post-traumatic changes give rise to clinical symptoms similar to those of cardiospasm. Carcinoma of the lower end of the esophagus and cardia may give great difficulty in diagnosis. This situation is especially likely in those cases in which carcinoma arises in the cardia and infiltrates under the esophageal mucosa, producing esophageal obstruction without evidence of ulceration or tumefaction. Although as a rule carcinoma does not give rise to

154. Moersch, H. J.: Problems in Differential Diagnosis of Lesions of the Lower Portion of the Esophagus and the Cardia, Ann. Otol. Rhin. & Laryng. **61**:976 (Dec.) 1952.

marked dilatation of the esophagus proximal to the site of the obstruction, at times the dilatation may be so great that it will closely simulate cardiospasm. Biopsy is indispensable in the diagnosis, but in the experience of the Mayo Clinic 10% of carcinomas of the esophagus and 25% of carcinomas of the cardia yielded negative information on biopsy. Considerable help has been obtained by removing secretions from the site of obstruction for cytologic examination. Material is obtained by the passage of sounds, and the smears are taken directly from the sound. Although benign tumors of the esophagus are not common, when they do occur they offer great difficulty in differential diagnosis. This is true not only of mucosal tumors but also of intramural and extramucosal tumors. Hiatal hernia frequently causes difficulty in differential diagnosis of lesions involving the cardia. This problem is accentuated by the fact that hiatal hernia not only may vary in size and type but, owing to ulceration, may simulate secondary spasm of the esophagus. The problem is further complicated by the fact that the hiatal hernia may not be the primary lesion but a secondary manifestation of such diseases as carcinoma, scleroderma, esophagitis, and cicatricial stenosis of the esophagus. Foreign bodies may become lodged in the hiatal hernia, or other diseases may develop in the hernia, altering the findings and suggesting other diagnoses. In all these espohageal lesions endoscopic examination is vital in arriving at the correct diagnosis.

ESOPHAGEAL HIATAL HERNIA

In a series of 559 cases Harrington [155] emphasized the importance of roentgenologic and esophagoscopic manifestations of esophageal hiatus hernia.

A case of paraesophageal hiatus hernia in a newborn infant was reported by Johnson and Mangiardi.[156]

In a brief review of the literature Feldman and Myers [157] discovered 43 cases of gastric carcinoma coexistent with hiatal hernia, and they added 3 new cases. It was pointed out that the incidence of carcinoma in patients with hiatal hernia is not statistically significant.

Pack and his associates [158] reported two cases of carcinoma occurring in a thoracic stomach. In one case the cancer developed in the segment of stomach which participated in a diaphragmatic hernia. In the second case there was a hiatal hernia with a long history of dysphagia, esophagitis, and pain. Only the development of serious hemorrhage led to further investigation and discovery and treatment of a carcinoma in the intrathoracic gastric segment.

THORACIC STOMACH

In a study of 112 children with minor degrees of partial thoracic stomach Carre and his associates [159] found vomiting a common symptom. Whatever the basic defect,

155. Harrington, S. W.: Esophageal Hiatus Diaphragmatic Hernia, Rocky Mountain M. J. **49**:665 (Aug.) 1952.

156. Johnson, E. K., and Mangiardi, J. L.: Diaphragmatic Hernia in the Newborn, A. M. A. Am. J. Dis. Child. **84**:436 (Oct.) 1952.

157. Feldman, M., and Myers, P.: The Coexistence of Carcinoma of the Stomach and Esophageal Hiatus Gastric Hernia, Am. J. M. Sc. **224**:519 (Nov.) 1952.

158. Pack, G. T.; Butler, F. S., and Katz, E.: The Development of Cancer in Dystopic and Ectopic Thoracic Stomachs, J. Thoracic Surg. **23**:593 (June) 1952.

159. Carre, I. J.; Astley, R., and Smellie, J. M.: Minor Degrees of Partial Thoracic Stomach in Childhood, Lancet **2**:1150 (Dec. 13) 1952.

the cause of the symptoms is the same, i. e., incompetence of the esophageal sphincter, permitting reflux of gastric contents into the esophagus. Seventy-five per cent of the children had a relatively short and benign course, with gradual symptomatic cure even in those with prolonged vomiting. An esophageal stricture developed in only a small proportion.

DIVERTICULUM OF ESOPHAGUS

Five cases of traction diverticula of the midesophagus in association with chronic middle lobe disease were reported by Katz.[160]

In a study of the medical literature Goodman and Parnes[161] found 126 reliable reported cases of epiphrenic diverticula of the esophagus, and they added two of their own cases. Epiphrenic diverticula located just above the diaphragm contain all the layers of the esophagus and are produced by pulsion or pressure. In about 65% of the cases reported there was associated cardiospasm. The weakness in the muscular layer of the esophagus which makes possible this type of diverticula was thought to be either congenital or due to localized esophagitis, permitting the constant pressure of swallowed food to form a diverticulum. The symptoms of epiphrenic diverticula of the esophagus were usually not clear-cut and sometimes not directly related to the esophagus. Patients with gastrointestinal symptoms complained of dysphagia, epigastric pain, vomiting, substernal distress, anorexia, belching, loss of weight, gurgling noises in the sac, heartburn, and regurgitation of blood. Depending on the severity of symptoms, the treatment varied from no treatment at all to the use of a bland diet, sedatives, and antispasmodics and surgical extirpation. Five indications for operation were listed.

DeBakey and Creech[162] found that the symptoms produced by epiphrenic esophageal diverticulum were the result of certain complications, such as partial obstruction resulting from distortion and angulation of the esophagus, inflammation and ulceration with consequent stricture formation, perforation, hemorrhage, or a malignant growth. This diverticulum is generally considered to be of the pulsion type, resulting from herniation of the mucous membrane through the muscular wall, probably in an area of congenital weakness, and is encountered infrequently. For all epiphrenic esophageal diverticula which produce symptoms, surgical treatment is indicated.

In reporting a case of epiphrenic diverticulum of the esophagus, Kausel and Lindskog[163] pointed out that absence of the muscular layers is characteristic of this type of diverticulum, in contradistinction to the traction type, in which all layers of the esophageal wall are represented. Two complications of epiphrenic esophageal diverticulum which justify surgical treatment were listed: the presence of an unexplained foreign body and ulceration. On esophagoscopic examination in the authors' case the esophagus appeared normal up to the mouth of the diverticulum about

160. Katz, H. L.: Traction Diverticula of the Esophagus in Middle Lobe Syndrome, Am. Rev. Tuberc. **65**:455 (April) 1952.

161. Goodman, H. I., and Parnes, I. H.: Epiphrenic Diverticula of the Esophagus, J. Thoracic Surg. **23**:145 (Feb.) 1952.

162. DeBakey, M. E., and Creech, O.: Surgical Treatment of Epiphrenic Diverticulum of the Esophagus, J. Thoracic Surg. **23**:486 (May) 1952.

163. Kausel, H. W., and Lindskog, G. E.: Epiphrenic Diverticulum of the Esophagus: A Review of Its Surgical Treatment and Report of a Case, Dis. Chest **21**:334 (March) 1952.

40 cm. from the upper gum margin. The sac was filled with foreign body material, and as much as possible was removed with forceps. It was found to be composed chiefly of vegetable fibers and amorphous debris. Because of this material in the sac poor filling of the diverticulum had been shown on the roentgenogram, raising the question of carcinoma. No evidence of neoplasm was found on esophagoscopic examination, and the ulceration detected on opening the sac at operation was not discovered on esophagoscopy.

ACHALASIA

Graham [164] pointed out that the origin of cardiospasm is still unknown but is thought to be a disturbance of the neuromuscular mechanism, particularly the sympathetic system. Irregularity of peristalsis was observed in all cases. The differential diagnosis included carcinoma and peptic esophagitis. All patients were given a trial period of dilatation, a Plummer dilator being passed over a previously swallowed string. Approximately 70% of patients were symptomatically cured by this method. When surgical treatment was necessary the Heller operation, with splitting of the circular muscle fibers longitudinally, gave the best results.

In discussing a case of carcinoma of the esophagus complicating cardiospasm, Gore and Lam [165] advised the more frequent use of esophagoscopy for cardiospasm. Since dysphagia is already present, this symptom is valueless in the diagnosis of a malignant growth which develops in association with achalasia. Direct examination would seem the only means of uncovering malignant change. Since the factor of chronic irritation with inflammatory changes and leucoplakia is present in cardiospasm, the development of cancer of the esophagus in patients with this condition may eventually shed some light on the pathogenesis of this and other malignant lesions.

BOUGIENAGE FOR BENIGN ESOPHAGEAL OBSTRUCTION

Richards and Dietrich [166] discussed blind bougienage in the treatment of benign esophageal obstruction. A detailed analysis of 75 patients treated by this method was reported. They were divided into four groups: (1) patients with a clear history of ingestion of some caustic substance, with resultant cicatricial stenosis; (2) patients with webs in the cervical segment of the esophagus; (3) patients with fibrosis, sometimes of congenital but more often of unknown etiology, and with obstruction occurring most often in the middle and lower thirds of the esophagus, and (4) patients with terminal fibrosis or achalasia. Twenty patients with achalasia were treated actively and intermittently by blind bougienage for an average of eight years. The mercury, or Hurst type, of bougie was used in the treatments ranging in size from 36 F. to 62 F. An average of 60 dilatations per patient were performed, and the maximum number for a single patient was 192. Sixteen patients were classified as having esophageal webs and were generally freer of symptoms and more comfortable during the time between treatments than those with achalasia. They

164. Graham, J. M.: Dysphagia with Special Reference to Cardiospasm, Tr. Med.-Chir. Soc. Edinburgh **59**:1, 1951-1952, in Edinburgh M. J. (April 4) 1952.

165. Gore, I., and Lam, C. R.: Carcinoma of the Esophagus Complicating Cardiospasm, J. Thoracic Surg. **24**:43 (July) 1952.

166. Richards, L., and Dietrich, H. J., Jr.: Blind Bouginage in the Treatment of Benign Esophageal Obstruction, Ann. Otol. Rhin. & Laryng. **61**:1134 (Dec.) 1952.

received dilatations for an average of eight years, and the average number of dilatations per patient was 63. There were 12 patients with esophageal obstruction from the ingestion of lye, and these received an average of 30 bougienages per patient, with the attainment of an average lumen diameter of 34 F. The impression was gained that cicatricial stenosis caused by caustic ingestion dilated more easily than that due to obstruction from webs or to achalasia. More rapid attainment of an adequate lumen for comfortable swallowing was achieved in the lye-stricture cases. Twenty-five patients with obstruction in the middle and lower thirds of the esophagus of obscure origin received dilatations for ten years, with an average of 43 dilatations per patient. Many of these patients remained symptom free for long intervals before returning for dilatation. All the patients treated maintained a satisfactory nutritional level, could eat comfortably, and appeared greatly benefited by bougienage treatment.

Utilizing the experiences of others in the rapid passage of intestinal decompression tubes, Aves and his co-workers [167] substituted a small mercury-laden rubber bag as the bolus for the esophageal dilator guide string. The method was used in 12 cases, and the authors were impressed by the speed, safety, and reliability of this method. The mercury-bag bolus was used only as a means of carrying the string down into the gastrointestinal tract and was not intended to serve as a bougie. The mercury-bag propelled string can be swallowed at night and esophageal dilatation accomplished the following morning. By the weight of the mercury bag one is aware of its passage through the stenosis, and after proper positioning of the patient its passage through the pylorus can frequently be determined in a matter of minutes. The use of swallowed string for esophageal dilatation is contraindicated in the presence of an anatomic loop, such as a gastroenterostomy or enteroenterostomy, at any level in the gastrointestinal tract, for the string may circle a loop and cut or ulcerate the mucous membrane. A mercury-bag bolus which is too large or too heavy may fail to pass the pylorus or, having passed, may pull so strongly on the attached string that cutting of the nasopharyngeal or intestinal mucosa results. Accidental rupture of the bag, releasing metallic mercury into the intestinal tract, is a complication which may occur, but in general free metallic mercury within the gastrointestinal tract is harmless and nontoxic.

CARCINOMA OF ESOPHAGUS

Merendino and Mark [168] analyzed 100 cases of squamous cell carcinoma of the esophagus with particular reference to the factors involved in delay in diagnosis and therapy. Although dysphagia developed comparatively late in the course of this disease, for practical and diagnostic purposes it was the first symptom. Any degree of dysphagia must be considered as indicative of carcinoma of the esophagus until proved otherwise. Patients with this complaint should be subjected to roentgen visualization of the esophagus and stomach followed by esophagoscopy. Education of both the general public and the practicing physician as to the seriousness of this

167. Aves, F. H.; Desforges, G., and Strieder, J. W.: Mercury-Bag Bolus to Expedite Passage of Esophageal Dilator Guide String, J. Thoracic Surg. **24**:34 (July) 1952.

168. Merendino, K. A., and Mark, V. H.: Analysis of 100 Cases of Squamous Cell Carcinoma of the Esophagus with Special Reference to Delay Periods and Delay Factors in Diagnosis and Therapy: Contrasting State and City and County Institutions, Cancer **5**:52 (Jan.) 1952.

symptom is needed. When general awareness of the implication of dysphagia occurs, it is expected that the delay period from the onset of symptoms until the diagnosis can be reduced to two months. Symptomatic treatment or procrastination in any form when dysphagia is present was condemned. Starvation and dehydration as such did not necessarily indicate either inoperability or incurability. In the indigent population the patient was responsible for a delay of 90 days after esophageal symptoms apeared. An average delay of 35 days was found on the part of patients in state institutions before they consulted a private physician. The interposition of a private practitioner between the state institution patient and the hospital in which he received definite treatment resulted in an average delay of 108 days.

Parker [169] reviewed 170 cases of epidermoid carcinoma of the esophagus observed between 1940 and 1951. One of the reasons for poor results was the failure to establish the diagnosis before the patient had begun to lose weight from starvation. The author particularly studied 17 cases in which there were other apparent reasons for the delay in diagnosis. The reasons included lesions which did not obstruct the esophageal opening, lesions for which radiographic studies were negative and there was no further pursuit of the etiology of the presenting symptoms, lesions for which diagnostic studies and esophagoscopy gave negative results once but positive ones later, and lesions with symptoms directed toward the esophagus obscured by other diseases.

A case of primary melanocarcinoma of the esophagus was reported by Garfinkle and Cahan.[170] There was a history of swallowing a chicken bone, which was removed from the cervical esophagus by esophagoscopy, after which an upper mediastinitis developed. About five years after this episode substernal pressure and dysphagia developed. On esophagoscopy a lesion in the upper thoracic esophagus was found, and a histologic report of malignant melanoma was obtained from the biopsy.

ESOPHAGEAL VARICES

Three patients with massive hemorrhage from the upper portion of the esophagus in the absence of portal hypertension were presented by Palmer.[171] In all cases bleeding varices of the posterior esophageal wall were found in the region just below the cricopharyngeus. It was felt that these varices were the result of abnormally caudad portions of the posterior hypopharyngeal plexus, which had been constricted by the cricopharyngeus. Esophagoscopic examination is essential in all cases of unexplained gastrointestinal bleeding.

Complications in the use of esophageal compression balloons for control of bleeding from esophageal varices were discussed by Bennett and his associates.[172] Traumatic injury results from unintentional withdrawal of the tube before deflation, undue traction on the tube, and pressure on the posterior portion of the larynx and trachea. Esophageal ulceration may produce serious consequences.

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169. Parker, E. F.: Difficulties in the Diagnosis of Carcinoma of the Esophagus, Am. Surgeon **18**:1082 (Nov.) 1952.

170. Garfinkle, J. M., and Cahan, W. G.: Primary Melanocarcinoma of the Esophagus, Cancer **5**:921 (Sept.) 1952.

171. Palmer, E. D.: Primary Varices of Cervical Esophagus as a Source of Massive Upper Gastrointestinal Hemorrhage, Am. J. Digest. Dis. **19**:375 (Dec.) 1952.

172. Bennett, H. D.; Baker, L., and Baker, A.: Complications in the Use of Esophageal Compression Balloons (Sengstaken Tube), A. M. A. Arch. Int. Med. **90**:196 (Aug.) 1952.

Rack and co-workers [173] reported a case of massive hematemesis from esophageal varices, proved by both roentgenography and esophagoscopy, for which no cause could be established. Although portal hypertension is the usual cause of esophageal varices, eight additional cases were listed in which such varices were associated with other abnormalities.

FOREIGN BODIES IN THE GASTROINTESTINAL TRACT

A radiopaque string attached to the end of a magnet by a cap with a hole in it was used by Equen and Brown [174] for the removal of foreign bodies in the duodenum. Under the fluoroscope the course of the magnet and string was followed, and more or less of the string necessary to contact the foreign body was swallowed or withdrawn.

In two cases successful peroral removal of magnetic foreign bodies in the food passage beyond the pylorus was accomplished by Dorenbusch [175] with the Alnico magnet. In one case, that of a hatpin in the duodenum, the foreign body stripped off at the cricopharyngeus on several attempts, necessitating ether anesthesia for relaxation. The other case involved a 6-penny finishing nail in the jejunum of a 26-month-old child, which was easily removed as soon as the magnet caught up with the nail.

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173. Rack, F. J.; Mincks, J. R., and Simeone, F. A.: Observations on Etiology of Esophageal Varices, A. M. A. Arch. Surg. **65**:422 (Sept.) 1952.

174. Equen, M., and Brown, R.: An Improved Magnet and Radiopaque String, Tr. Am. Acad. Ophth. **56**:95 (Jan.) 1952.

175. Dorenbusch, A. A.: Ferromagnetic Foreign Bodies Beyond the Pylorus: Report of 2 Cases in which Successful Peroral Removal was Accomplished by Use of Alnico Magnet, A. M. A. Arch. Otolaryng. **55**:589 (May) 1952.

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Mfr., Mears Radio Hearing Device Corporation
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Micronic Model Mercury

Micronic Star Model
Mfr., Audivox, Inc.—Successor to Western Electric Hearing Aid Division
123 Worcester St.
Boston 18

Microtone Classic Model T-9

Microtone Models T-10, T-612, & 45
Mfr., The Microtone Company
Ford Parkway on the Mississippi
St. Paul 1

National Model D (Duplex)

National Ultrathin Model 504

National Vanity Model 506
Mfr., National Hearing Aid Laboratories
106 S. 7th St.
Philadelphia 6

Normatone Model C
Mfr., Johnston Hearing Aid Mfg. Co.
708 W. 40th St.
Minneapolis 8
Distr., Normatone Hearing Aid Co.
22 E. 7th St.
St. Paul 1

Otarion Model E-4

Otarion Models F-1, F-2, & F-3

Otarion Models G-2 & G-3

Otarion Model H-1, Custom "5"
Mfr., Otarion, Inc.
4757 N. Ravenswood Ave.
Chicago 40

Paravox Model D (Top-Twin-Tone)

Paravox Model J (Tiny-Myte)

Paravox Model Y (YM, YC, & YC-7) (Veri-Small)
Mfr., Paravox, Inc.
2056 E. 4th St.
Cleveland 15

Radioear All-Magnetic Model 55

Radioear Permo-Magnetic (Multipower)

Radioear Model 62 Starlet

Radioear Model 72

Radioear Model 82 (Zephyr)
Mfr., E. A. Myers & Sons, Inc.
306 Beverly Rd.
Mount Lebanon
Pittsburgh 16
Distr., Radioear Corporation
306 Beverly Rd., Mount Lebanon
Pittsburgh 16

Silvertone Models J-92 & P-15
Mfr., Johnston Hearing Aid Mfg. Company
708 W. 40th St.
Minneapolis 8
Distr., Sears, Roebuck & Co.
925 S. Homan Ave., Chicago 7

Solo-Pak Model 99
Mfr., Solo-Pak Electronics Corp.
Linden St.
Reading, Mass.

Sonotone Models 900, 910, 920, 925, 940, 960, & 977
Mfr., Sonotone Corporation
Elmsford, N. Y.

Televox Model E
Mfr., Televox Mfg. Company
1307 Sansom St.
Philadelphia 7

Telex Models 99, 200, 300-B, 400, 500, 952 953, & 1700
Mfr., Telex, Inc.
Telex Park
St. Paul 1

Tonamic Model 50
Mfr., Tonamic, Inc.
12 Russell St.
Everett 49, Mass.

Tonemaster Cameo Model

Mfr., Tonemaster, Inc.
400 S. Washington St.
Peoria 2, Ill.

Unex Midget Models 95 & 110

Unex Models 200 & 230

Mfr., Nichols & Clark
Hathorne, Mass.

Vacolite Models J & J-2

Mfr., Vacolite Company
3003 N. Henderson St.
Dallas 6, Texas

Zenith Miniature 75

Zenith Model Royal

Zenith Model Super-Royal

Zenith "Regent"

Mfr., Zenith Radio Corporation
5801 W. Dickens Ave.
Chicago 39

(All the accepted hearing devices have vacuum tubes.)

Accepted hearing aids more than five years old have been omitted from this list for brevity.

SEMIPORTABLE HEARING AIDS

Ambco Hearing Amplifier (Table Model)

Mfr., A. M. Brooks Company
1222 W. Washington Blvd.
Los Angeles 7

Aurex Semi-Portable

Mfr., Aurex Corporation
1117 N. Franklin St.
Chicago 10

Precision Table Hearing Aid

Mfr., Precision Hearing Aids
5157 W. Grand Ave.
Chicago 39

Sonotone Professional Table Set Model 50

Mfr., Sonotone Corporation
Elmsford, N. Y.

Society Transactions

AMERICAN LARYNGOLOGICAL ASSOCIATION

Seventy-Fourth Annual Meeting, New Orleans, April 26-27, 1953

Louis H. Clerf, M.D., *President*

Harry P. Schenck, M.D., *Secretary*

Abstracted by

Samuel Salinger, M.D.

Primary Plasma Cell Tumors of the Upper Air Passages. Dr. Clyde A. Heatly, Rochester, N. Y.

Dr. Heatly, in surveying the literature, found only 175 cases reported, many of them incomplete. These tumors are primarily of lymph origin and in some respects resemble multiple myeloma, differing mainly in their slower development and slightly different morphology, as found by various laboratory tests and x-ray examination. As a rule, they are solitary, although at times multiple, and may occur anywhere in the upper air passages. They are very vascular, usually spread superficially, and tend to metastasize to the nodes and bones, rarely to the lungs and other organs. There is some doubt as to whether these are true metastases, some authors believing the growths to be of multiple origin. The tumors should be generally classified as malignant and so treated. They are usually sensitive to irradiation, which should be combined with surgery. Heatly found 23 cases involving the antrum reported in the literature. Two of his own cases were reported with a full description of the histologic picture.

DISCUSSION

Dr. Julius McCall reported that he had recently observed his 16th case in a man of 41. The tumor looked like a laryngeal polyp, cherry-red in color, about 1 cm. in diameter, and situated at the anterior commissure. It was removed and diagnosed as a plasmocytoma. Histologically the cells failed to show mitoses; this, of course clouds the diagnosis of a malignant growth. He asked Dr. Heatly whether in such a case treatment should be expectant or the patient be subjected immediately to x-rays and more extensive surgery.

Dr. Maloney reported a case in a middle-aged Negro woman who suffered marked dyspnea because of the size of the growth. It was removed by direct laryngoscopy, which was followed by a full course of radiation therapy. A complete survey of the entire skeletal system and sternal marrow and iliac crest punctures failed to reveal any evidence of multiple myeloma, with which it might have been confused. Up to one year later, examination of the patient showed no evidence of recurrence or metastasis.

Dr. Frederick A. Figi was impressed by the distinction between inflammatory plasma cell lesions and the true neoplasm as described by Dr. Heatly. It is the former type which is more readily confused with myeloma. The course of these tumors is often unpredictable. Two cases in point were cited. One patient had an extensive plasmocytoma involving the antrum and ethmoid; it was treated by electrocoagulation and by intracavity and external irradiation and has remained cured for 11 years. The other patient had a lesion on the posterior aspect of the epiglottis, which was similarly treated. At that time it was diagnosed as a hemiangioma, but a recent review proved it to be a plasmocytoma. As to metastases, Dr. Figi has found in his experience that they affect the bones more commonly than the lymph nodes, leading him to suspect that the spread is along hematogenous routes.

Dr. Heatly replied to Dr. McCall by stating that his procedure would be to follow the removal of the growth by a full course of irradiation. He did not believe that a thyrotomy would be of much advantage.

The Mesenchyme of the Nose and Sinuses. DR. AUBREY G. RAWLINS, San Francisco.

Interest in the mesenchyme has received new impetus in recent years through the medium of newer techniques, the electron microscope, tissue cultures, and the observations of the effect of corticotropin (ACTH) and of cortisone therapy. The mesenchyme, which is the precursor of adult connective tissue, varies in amount in relation to cell content. Photographs with special stains under the electron microscope show the finer details of the fibrils. The function of this tissue is to serve mainly as a barrier against the spread of infection; therefore, its density is an important factor. The balance between the amount of hyaluronidase and antihyaluronidase in the tissue also determines its resistive power against infection. Stimulation of the adrenal cortex increases the amount of the antisubstance which is helpful in overcoming infection. The function of ascorbic acid was also discussed as an effective agent in the production of the stress hormone. It also aids in the production of new fibrils in the ground substance. The mechanism of edema is explained as being either a transudate from the capillaries or a direct production of the ground substance.

DISCUSSION

DR. ARTHUR PROETZ stressed the importance of the mesenchyme in the reaction of the patient to insult. This reaction is not only variable among different persons but also variable in the same person at different times. The interesting study presented by Dr. Rawlins affords a new avenue for investigating the changing character of the patient's response to infection under varying conditions. The beautiful pictures of connective tissue cells as viewed under the electron microscope are a revelation which should certainly inspire young investigators looking for new fields of research.

DR. BERNARD J. MCMAHON recalled a report he had made some years ago on the fate of particulate matter injected into the turbinates. It was revealed that the carbon particles traveled through the subepithelial issues to the perivascular lymphatics and, thence, to the lymphatic glands. It was also revealed that carbon particles were fixed by the phagocytes and histiocytes. A question that was posed at the time, and is still a matter of speculation, is whether the electric potential of the foreign matter or bacteria and that of the patient may not be a factor in the determination of spread or control, possibly being variable at different times of the day or season.

DR. FRANCIS L. WEILLE mentioned a finding recorded by research workers at the Massachusetts General Hospital, in which the cross striations in the fibrils, as viewed under the electron microscope, could be made to disappear by changing the saline concentration and then to reappear when more saline was added. Does Dr. Rawlins have any explanation of this phenomenon?

DR. RAWLINS mentioned the importance of the fibroblasts as active agents in the antibacterial function of the ground substance. Collagen seems to be a percipitative protein. Molecular proteins precipitate in such a way that the striations of the fibrils are regularly spaced. Investigators have been able to take certain proteins and combine them in such a way as to form fibrils almost exactly like those observed under the electron microscope.

Primary Amyloid Disease of the Larynx. DR. JULIUS W. MCCALL, Cleveland.

Solitary amyloid tumors are less common than multiple lesions. Cases involving the larynx are rather rare, although some clinics report a higher incidence than others. Dr. McCall has observed four cases during a three-year period. Thirteen cases have been recorded in the Cleveland Clinics over a 15-year period. The lesion may be asymptomatic for a long time, hoarseness being the earliest sign and dyspnea appearing when the mass becomes larger. It appears as a diffuse submucous thickening or a yellowish or yellow-red hue. In composition it is a mixture of proteins and polysaccharides. One patient was treated with corticotropin (ACTH), 100 mg. per day for 14 days, when a reaction supervened. However, the voice improved, and the mass disappeared for the most part. In another case cortisone was injected several times daily, but up to six weeks there appeared to be no response. The dose was increased until marked vertigo developed. The mass was not affected and a thyrotomy may have to be performed. In the third case there were several small red masses on both vocal cords. Cortisone injected directly into the masses effected a reduction in size, and the voice was improved.

DISCUSSION

DR. IRL H. BLAISDELL reported a follow-up on the patients treated with corticotropin. The voice deteriorated for a while but improved after a second course of corticotropin and the mass receded almost completely.

DR. HUGH G. BEATTY reported that he had operated on a patient who previously had been under Dr. Schall's care. The mass was rather large, occupying part of the pharyngeal wall as well as the larynx. Despite the removal of a mass measuring 3 by 1.5 by 0.5 cm., some of the growth was still present after several months.

DR. LEROY A. SCHALL commented on the value of attending these meetings where occasionally one discovers what happens to a patient who leaves for another city. The patient whose case was discussed by Dr. Beatty had been under his care in 1946, at which time smooth granular masses were observed involving part of the cords and the aryepiglottic folds. Biopsy revealed amyeloid tissue, and a subsequent operation was only partially successful.

DR. PAUL H. HOLINGER wondered whether in some of these cases the masses are true amyloid tumors or just amyloid deposits. Congo red tests are usually helpful in making the differential diagnosis.

DR. MCCALL said that the Congo red test was not performed. However, reports from three separate biopsies in one case all stated that the growth was a true amyloid tumor. The methyl violet stain was used.

The Laminograph as an Aid in the Diagnosis of Diseases of the Larynx. DR. LEROY A. SCHALL, Boston.

Dr. Schall described the mechanism of laminography and discussed its value in roentgenography of the larynx. This organ is a favorable object for this technique because of the different densities of the cartilage, osteoid plaques, and the air spaces—all of which afford good contrast. He showed several typical pictures in which growths involving various parts of the larynx were more fully outlined than in the conventional projections. It is, therefore, a valuable adjunct in diagnosis.

DR. HENRY B. ORTON has used laminography for a number of years and finds it very useful, particularly in obscure cases. He showed slides illustrating three cases: one, a case of sarcoma; the second, a case of syphilitic swelling, and the third, a case of carcinoma.

DR. C. L. JACKSON employs laminography in practically all cases in which x-ray pictures are taken. It has proved most useful in showing the extent of tumors in the subglottic area as well as those invading the ventricular bands.

DR. SAMUEL SALINGER called attention to the fact that originally laminograms could be obtained only by use of specially built machines, which cost several thousand dollars. However, in recent years a detachable apparatus has been made available which can be set up on any good x-ray machine and can do work as well as the more expensive machines. Since they cost only a few hundred dollars, they should not be beyond the means of the average x-ray laboratory.

DR. PAUL HOLINGER asked whether Dr. Schall had taken lateral laminograms as well as the anteroposterior ones he showed. he believes that the lateral projections are of especial value in cases in which the shoulders and the larynx are unusually low and also when the thyroid cartilages are extensively ossified.

DR. SCHALL added that he should have emphasized the value of this procedure in visualizing lesions in the upper surface of the vocal cord, in the ventricles, which are often difficult to diagnose by either direct or indirect laryngoscopy. Referring to the cost of the apparatus, he mentioned Dr. LeBourget's statement that he could make an apparatus with a piece of pipe and a couple of boards for about $9.00! However, the machine Dr. Schall uses was manufactured by the Westinghouse Company for about $900.00.

In reply to Dr. Holinger, Dr. Schall stated that he has used lateral as well as anteroposterior projections, time not permitting him to show all his slides.

Clinical Significance of Laryngeal Keratosis as a Premalignant Lesion. Dr. F. J. Putney and Dr. John J. O'Keefe, Philadelphia.

It is well known that keratosis offers fertile soil for the development of carcinoma. Laryngeal keratosis usually develops as a result of chronic irritation. Most of the patients are smokers, only 11% of the authors' series being nonsmokers. Among 125 cases that were analyzed, the lesions in 57 were malignant when first examined; in 27 they were benign at first, later becoming malignant, and in 41 they remained benign. An inflammatory reaction may signify an early predilection for malignancy. The earliest signs of this tendency are to be found in intracellular changes, even before the basement membrane is invaded. It is often difficult to differentiate the preinvasive type while changes are limited to the cell structure itself, and this, naturally, influences the decision as to the therapeutic procedure.

Another complicating factor arises when the lesions are multiple. Also there frequently is a tendency toward recurrence. Radiation may cause the carcinoma to disappear while leaving the keratosis unaffected. In most cases electrocoagulation will successfully destroy the keratosis and, if combined with irradiation, may completely control the situation. In any event, these cases have to be carefully watched, clinically as well as histologically.

DISCUSSION

Dr. John J. O'Keefe emphasized the complex nature of this lesion and the difficulty at times in establishing its true status as benign or malignant. While repeated histologic studies are of great value, clinical judgment may have to be relied on when it comes to a decision as to conservative or radical surgery.

Dr. Francis LeJeune finds the number of cases increasing in recent years as a result of increasing consumption of tobacco. He has found the condition to be rather common among truck drivers who smoke a great deal to keep themselves awake. Some persons are more sensitive to the products of combustion, accounting for the wide variation of incidence among various classes. LeJeune suggests that biopsy specimens should be taken deeply enough to include some tissue beyond the manifest lesion. Also, he feels that one must be emphatic enough to impress patients, especially women who smoke to excess, with the danger of development of cancer. He is interested in knowing more about the effects of irradiation in these cases.

Dr. Louis H. Clerf was also impressed with the increasing incidence of this condition, particularly in women. Much of the irritation arises from the combustion of the paper wrapping, which has been chemically treated. The lesion is much less common in cigar or pipe smokers. It is his experience that nodular or thick lesions are more likely to become malignant than the thin flat ones. In taking specimens for biopsy from both vocal cords, one should be careful to label them separately, since the histologic appearance may be different in the two sides.

Dr. Putney commented on the procedure of stripping the cords, mentioned by Dr. LeJeune, and stated that he also follows it in certain cases.

When radiation therapy is employed, from 5,000 to 6,000 r is given as a tissue dose. It is given through a 25 sq. cm. field in fractional doses over a period of four to five weeks.

Carcinoma in Situ of the Larynx. Dr. Alden H. Milled and Dr. H. Russell Fisher (by invitation), Los Angeles.

This entity was first described by Broders in 1932 and refers to an early malignant lesion which is strictly intraepithelial and noninvasive. It can be diagnosed only by histologic examination which reveals variation in the size and staining qualities of the nuclei, mitotic figures, and irregularity in the size and arrangement of the cells. One slide shown by Miller and Fisher demonstrates graphically the borderline between the regularly arranged, evenly stained normal cells and the disordered patch of abnormal cells constituting the lesion. There were eight cases of leukoplakia in this series of cases.

Stripping the affected cord may effect a cure if the lesion is superficial. In most cases it is safer to combine it with radiation therapy.

DISCUSSION

Dr. LeRoy Schall has not used the stripping technique in these cases. Radiation therapy has been successful when the lesion was superficial and bilateral and the cords were movable. Nevertheless, there have been cases in which the lesion was more deeply seated and thyrotomy or even laryngectomy was required.

Dr. Gabriel Tucker questioned the feasibility of cord stripping with or without radiation. Frequently an apparent cure is followed by recurrence which is more serious than the original lesion. He has obtained his best results through endoscopic excision of the lesion. Five such cases have been observed as cured for periods from three to eight years.

Dr. Paul H. Holinger felt that this paper could have been discussed with the previous one, since the lesions are similar and often appear together. The texture of the lesion and the ease or difficulty with which it is stripped from the cord may influence the decision as to further therapy. A lesion or plaque that fails to strip off cleanly may leave a portion still attached. In such a case, one may try radiation therapy if the invasion is not deep; otherwise the only recourse would have to be laryngectomy.

Dr. Louis H. Clerf would not be content with a histologic report based solely on the stripped-off mucosa. One should have an adequate margin of submucosa and surrounding healthy tissue to be able to define accurately the limits of the growth. In all cases in which the therapy is less than radical surgery, the patient must be impressed with the necessity of submitting to frequent examinations for several years before he can be pronounced reasonably safe from recurrence.

Dr. Walter P. Work suggested that the pathologist section the block tangentially if the original section proves inconclusive.

Dr. H. Russell Fisher stated that errors on the part of the pathologist can be minimized or avoided if the specimen is examined at various levels. He showed several slides which depict the progression from the normal cell pattern to the bizarre and irregular type which characterizes this lesion. Much can be learned from careful study of all the sections of the specimen because the lesion is often very small and can easily be missed.

Dr. Miller stated that radiation therapy has been used because it is not always possible to determine just which portion of the larynx may be the site of a carcinoma in situ. Radiation therapy will cover the entire larynx in such cases. Commenting on Dr. Holinger's remarks, he called attention to the fact that, while keratosis was present in half their cases, in the others the carcinomas were often small lesions which appeared benign and were completely removed by the biopsy. Being associated with a Tumor Board, he has been impressed with the number of cases of carcinoma in situ discovered in the cervix. This, perhaps, has influenced his attitude toward early study of all localized lesions, with the help of interested pathologists who are willing to take the time to examine all the sections.

Chordoma: Final Report and Reevaluation of Treatment. Dr. Henry B. Orton, Newark, N. J.

This case was originally presented before this Association by Dr. Imperatori. A follow-up examination revealed a recurrence in 1947, at which time the larynx was removed and a subhyoid pharyngotomy was performed, with excision of the mass in the pharynx. This was only a temporary success. A year later, dysphagia and swelling in the pharynx reappeared and some of the regional nodes became involved. X-rays and an operation revealed involvement of several of the cervical vertebrae causing neurologic manifestations due to involvement of the roots of spinal nerves. Laminectomy failed to yield much relief, and the patient died.

DISCUSSION

Dr. DeGraf Woodman reported that he had observed three cases and had operated in two of them. They all died. One, in which operation was done twice, was that of a middle-aged woman. A good part of the mass seemed to be encapsulated. However, the stalk appeared

to be attached to the bone marrow of the vertebra and its extent could not be accurately determined. Neither the orthopedic surgeon nor the neurosurgeon could offer anything promising a cure.

DR. SAMUEL SALINGER pointed out that these tumors originate from a vestige of the fetal notochord and, therefore, the difficulty in eradicating them can be readily visualized from the fact that there must always be a stalk of indeterminate length extending into the vertebrae. So far as his knowledge of the literature goes, he has never read of a case in which there was a cure. The situation is analogous to that of the thyroglossal cyst, whose stalk passes through the hyoid bone up to the base of the tongue. Fortunately, in this instance it is accessible for complete removal, which is not the case with a chordoma.

DR. ORTON recognized the similarity to the thyroglossal cyst and tract, which will recur if a portion of the hyoid bone is not removed. Possibly, the neurosurgeon and the orthopedist might work out a technique which would permit resection of the involved vertebrae, followed by adequate plastic repair.

Neurilemmoma (Schwannoma) of the Larynx. DR. L. CHESTER MCHENRY, Oklahoma City.

There is some confusion in the description of tumors arising from nerve tissues. McHenry chooses Stout's description, which he quotes. They arise from the sheath of Schwann, may involve any nerve or root having such a sheath, and may be single or multiple. They are characterized by palisading nuclei. Twenty-one cases involving the larynx have been reported in the literature. Neurilemmoma differs mostly in the size it may attain. He reports a case in a woman of 48. The left ventricular band was filled by a bulging mass which extended into the subglottic area and was too large to be removed endoscopically. A thyrotomy was done and the mass shelled out easily. It was a lobulated tumor consisting of palisading masses of cells typical of Schwann tissue.

DISCUSSION

DR. GABRIEL TUCKER showed a movie of such a tumor, which was removed via a thyrotomy without actual entrance of the larynx cavity. In a second case, the contents of the mass were aspirated and iodized oil U. S. P. (Lipiodol) was injected to outline the extent of the mass. One of the cases involved the ventricular band, and therefore the voice was not impaired by the surgery. In the other case the tumor was in the subglottic area. Here also the injection of iodized oil proved helpful.

DR. FREDERICK A. FIGI said that pathologists are not agreed on the nomenclature. Actually Schwannoma, neurilemmoma, and neurofibroma tend to follow the same clinical course. They develop slowly, and their histologic structure is very similar. At the Mayo Clinic, the tumors are usually designated as neurofibromas. Dr. Figi and Dr. Stark are going to present a series of five such cases before the coming meeting of the American Laryngological, Rhinological and Otological Society, Inc., one of the cases had previously been presented by Drs. New and Devin, and in another malignant changes were manifested.

Hemilaryngectomy and Subtotal Laryngectomy with Immediate Skin Graft. DR. FREDERICK A. FIGI, Rochester, Minn.

Dr. Figi presented a preliminary report on this technique three years ago. Two patients operated on five years ago are alive and well. Since then, 18 patients have been similarly operated on and the technique has proved its value. Each of these patients would otherwise have had to undergo a laryngectomy. The procedure described had saved enough of the larynx to provide adequate airway and something of a voice. It is indicated in cases of laryngeal carcinoma of low-grade malignancy in which removal of half of the larynx and cricoid cartilage may completely encompass the malignant growth. The immediate application of a skin graft prevents collapse of the tissues and ensures an adequate lumen. This graft is applied on a stent, which is removed in 10 days and replaced by an elastic dilator for a similar period. There have been no recurrences to date. One patient died of a coronary attack.

DISCUSSION

Dr. Francis LeJeune lauded the presentation and described the procedure as a most valuable adjunct in the treatment of carcinoma of the larynx, since it points to a method whereby a number of patients otherwise doomed to a laryngectomy may achieve a cure with preservation of the normal airway and a voice.

Dr. Henry B. Orton wondered whether this procedure might not lead to a reclassification of the indications for laryngectomy. However, it will be most important to review these cases after the five-year period before drawing definite conclusions. He asked whether the presence of metastatic involvement of nodes would be a contraindication for this operation, other things being equal.

Dr. C. L. Jackson was very much impressed with Dr. Figi's presentation. For years American laryngologists have more or less frowned on hemilaryngectomy, despite its favor in Europe. Dr. Figi has shown how this procedure can be adapted to certain conditions with better prospects for the preservation of function than ever before. He personally has experimented with a very similar procedure, having used it in nine cases in the past year; in eight of these a mold was used, but grafting was done in only four. In one case the patient had so much difficulty in swallowing that it later became necessary to remove the rest of the larynx. In two of the cases the operations were performed according to the Alonzo technique—one in two stages and one in a single stage.

Dr. Gabriel Tucker has attempted to cover the defect left by this type of operation with mucous membrane from the epiglottis after removal of the cartilage. If the procedure is successful, mucous membrane should prove a better lining than skin, whose squamous character is less adaptable to the location.

Dr. Surola (Finland) described a plastic flap used by Dr. Meurmann and himself to cover a defect after the removal of a tumor of the vocal cord. It is in the nature of a skin flap taken from the skin of the neck adjacent to the wound and turned inward to be sutured to the margins of the mucous membrane about the defect.

Dr. Louis H. Clerf indicated that the great advantage of the immediate skin graft was the fact that it prevents the development of masses of granulation, which inevitably lead to constriction of the airway.

Dr. Henry M. Goodyear commented on trends in laryngeal surgery from the radical stand of MacKenty to the conservatism of Jackson, each based on premises valid enough at the time. He has felt that in many cases too much tissue has been sacrificed and has therefore been deeply interested in partial laryngectomies. One patient operated on 18 years ago lived for 15 years without recurrence. The risk of stenosis is most acute when the cricoid cartilage is partly excised. He has used mucous membrane to cover the defect, and he wonders how Dr. Figi feels about the persistence of dermal lining in a space that should normally contain mucous membrane.

Dr. Figi closed the discussion by first replying to Dr. Orton's question. There were no involved nodes in any of his cases. This procedure would not be indicated if the lymph nodes are involved. Concerning the mucosal flap from the epiglottis or the external skin flap of Meurmann, it is possible they might be useful. However, the skin flap takes up too much space because it requires a thick pedicle if it is to survive; experience with scalp flaps has proved this to be true. As to obturators, he has found the soft compressible obturator much more satisfactory than the hard ones suggested by Dr. Goodyear.

Treatment of Hyperplastic Sinusitis. Dr. Francis W. Davison, Danville, Pa.

Dr. Davison described various pathologic states found in chronic sinusitis and appraised the relative importance of allergy and bacterial invasion in the individual case. The diagnosis of these factors is important in the therapy, and Davison stressed the role of sensitivity to bacteria as a more or less neglected factor. Sinus washings should be carefully studied, especially in cases of asthma and bronchiectasis. Autogenous vaccines properly administered in connection with therapy directed at the elimination of food or air-borne allergens will

achieve results otherwise not attainable. In addition, if sensitivity tests are performed with the bacteria recovered from the sinus, adequate antibiotic therapy in doses up to 4,000,000 or 5,000,000 units daily will often produce a favorable response without recourse to surgery or, at least, limit intervention to less than a radical operation. Cortisone may have some value in shrinking hyperplastic tissue. Proper evaluation of the various factors mentioned is necessary for intelligent management of a given case.

DISCUSSION

DR. WATT W. EAGLE has been interested in bacterial allergy and considers it an important factor. However, he treats his patients somewhat differently. Penicillin is not used preoperatively, but an attempt is made to reduce edema of the tissues through the use of phenylpropanolamine hydrochloride (Propadrine) and calcium gluconate, the latter being administered both before and after the operation. Spread of infection during the winter months is often due to the dry superheated atmosphere in schoolrooms and at home. Steam vaporizers are needed to settle the dust which is inhaled along with bacteria. He agrees with Dr. Davison on the value of properly administered autogenous vaccines in the therapy of chronic sinusitis.

DR. HENRY L. WILLIAMS was surprised to hear that in Dr. Davison's series 26% of the patients with allergy had unilateral sinusitis. In his experience nearly all such patients have had bilateral sinusitis. As to bacterial allergy, he is somewhat skeptical, being more inclined to judge the process as a reduction in local resistance caused by the allergy, which invites secondary bacterial invasion. His experience with vaccines and with cortisone has been disappointing, although the latter often gives temporary relief. In addition, there are dangers attending its use, which must be kept in mind. The type of surgery employed is important. For the antrum he has found intranasal antrostomy adequate, for the ethmoids, removal of the collagenous tissue, followed by radium irradiation. He has obtained some good results from the use of penicillin as described by Dr. Davison, but they are not as fully satisfactory as when the collagenous material is removed from the ethmoids. He still believes that allergy is the fundamental cause of these chronic states, with bacterial invasion a secondary contributing factor.

DR. BERNARD J. MCMAHON called attention to the difference between hypertrophic and hyperplastic changes, the former being reversible and the latter irreversible. When connective tissue develops in the subepithelial tissues, vessels are constricted, leading to chronic edema and polypoid degeneration. He agreed with Dr. Davison on the value of sensitivity tests but is not satisfied with the usual short determinations. He finds that 24-hour cultures are more satisfactory in determining the resistance of the various strains of bacteria that may be present. As to surgery, he believes that early beneficial results may be due to local shock from the trauma. In addition, he called attention to the importance of a study of the patient's general condition. A hypothyroid state is often a contributing factor, and good results will follow the use of thyroid extract, which he combines with *d*-amphetamine (Dexedrine) sulfate. He has also used autogenous vaccines with good results and advises taking material for cultures at intervals so that the vaccines may more accurately cover the organisms present, which frequently change during the course of the disease.

DR. SAM E. ROBERTS was unable to approve the large doses of antibiotics suggested by Dr. Davison for afebrile patients, in whom the bacterial factor was admittedly secondary to the allergy. He believes in the importance of taking pH readings as a guide to local and general administration of acids or alkalis, as the case may be. The influence of hormones on allergies has been noted in pregnant women, suggesting another avenue for investigation.

DR. ARTHUR W. PROETZ called attention to the studies of Drs. Dixon and McCall made some time ago, in which the mucosa of the nasal passages in laryngectomized patients was found to have returned to normal. This would seem to confirm the reversibility of certain pathologic states in the mucous membrane.

DR. HARRY P. SCHENCK recalled a paper which he had written in association with Dr. Kernan over 20 years ago, in which they had suggested that there was such a thing as bacterial allergy. He is still of the same opinion. Some of the poor results from vaccines may be due

to carelessness in obtaining the specimen for culture. His best results have been in cases in which the vaccine was made from a bronchoscopic aspiration, in which the risk of contamination is less than in nasal specimens. Bacterial allergy has failed to find favor because skin tests have been inconclusive. This is due to the fact that the antigens have been destroyed by the heat in their preparation. The reason pollen antigens are reliable is that they have not been subjected to high temperatures. Bacterial suspensions passed through a ball mill, which breaks them up, will produce more reliable reactions in skin testing. He suggested that more attention be paid to the reticuloendothelial cell in allergy because of their ability to break down the bacteria into a form which becomes antigenic and can possibly stimulate the plasma cells to become active in producing antigenic substances.

Dr. Fred W. Dixon, commenting on Dr. Proetz's reference to Dr. McCall's and his study of laryngectomized patients, added that further study revealed absence of colds in these patients. Also, polypi were never observed and the nasal mucosa looked normal. Ciliary activity was studied and also found to be normal.

Dr. O. E. Van Alyea added that, in addition to the measures outlined by Dr. Davison, one must not overlook the simple intranasal procedures which assist ventilation and drainage, namely, infracting the middle turbinate, Proetz displacement, and simple irrigation. He does not believe that there is such a thing as an irreversible change in the mucosa in these cases, except as a result of previous surgery, and asked whether one of the slides shown by Dr. Davison did not represent such a case.

Dr. Theodore E. Walsh has found through animal experiments that antigens are best produced through the activity of macrophages on the bacteria. He also found that bacteria killed by formalin would be ingested by the macrophages and result in the production of antigens.

Dr. Davison closed the discussion with several brief comments He agreed that vaccines had failed in the hands of many because of imperfect collection and preparation of the material. Concerning Dr. Williams' comment about the high incidence of unilateral allergy, he stated that the cases of his series were consecutive and not selected. He believes in bacterial allergy, first, because of cases of unilateral involvement, second, because of the history of acute onset; third, because of response to properly selected antibiotics, and lastly, because the symptoms can be exaggerated or re-created by too large a dose of the vaccine. Dr. McMahon was correct about the terminology, as was Dr. Van Alyea about the value of certain conservative local measures. Dr. Walsh was also correct in his statement regarding the value of vaccines properly prepared in stimulating the macrophages.

Recent Items on Anesthesia of Interest to Laryngologists. Dr. John Adriani (by invitation), New Orleans.

Dr. Adriani discussed the many refinements in anesthetic procedures which have made possible the prolonged procedures in head and neck surgery. Drugs which reduce the blood pressure are used when considerable bleeding is anticipated. These techniques require skilled technicians because of the danger of anoxia or thrombosis. However, in many cases the pressure has been kept as low as 60 to 80 for as long as an hour. Another valuable adjunct in anesthesia has been the introduction of muscle-relaxing agents, beginning with curare and progressing to the more refined products of the drug. He described the physiologic action of these agents by their blocking effect on the acetylcholine. Some of these agents have a longer effect than others, and counter agents to overcome their depressive action, such as succinylcholine, have proved effective. Dr. Adriani discussed the action of Efocaine in prolonging local anesthesia, but he did not advocate its use because it has been shown that its action is achieved through destruction of nerve endings and fibers, which makes the drug unsafe.

Another item of value mentioned by Dr. Adriani is a drug called nalorphine hydrochloride (Nalline) which has proved effective in overcoming the depression action of morphine in cases of overdose or addiction. Respiration is increased within 20 to 30 seconds. It is not effective, however, in barbiturate poisoning or in cyclopropane or paraldehyde depression.

The presentation was quite lengthy but full of valuable detailed information.

Pharyngeal and Laryngeal Phenomena of Vascular Origin. Dr. French K. Hansel, St. Louis.

There are a number of painful conditions about the nose and throat of vascular origin comparable to histamine cephalalgia. Common symptoms, in addition to pain, are constriction and dryness of the throat. The onset may be sudden, frequently occurring at night. The diagnosis can usually be established from the effects of histamine and other vasodilators. Severe attacks may be relieved by ergotamine tartrate with caffeine (Cafergot); more prolonged attacks, by Bellergal (a preparation containing Gynergen, Bellafoline, and phenylethylbarbiturate). Histamine, nicotinic acid, and other vasodilators may be given over longer periods. Dr. Hansel recommends giving the histamine in high dilutions (1:1,000,000).

DISCUSSION

Dr. Ernest M. Seydell has been interested in headaches for a number of years, especially the postoccipital myalgias. He is not satisfied with the term "tension headache" frequently applied to these conditions. He has found that relief may be obtained by cocainization of the sphenopalatine ganglion area, with use of a 4% solution followed by cocaine-epinephrine solution paste (so-called cocaine mud) on a small applicator. It has proved effective in relief of neck muscle spasm. In addition, Dr. Seydell prescribes histamine diphosphate (1:10,000) administered sublingually, 1 drop before each meal, with increase of the dose to 7 drops, provided there is no attack in the meantime.

Dr. Aubrey G. Rawlins mentioned that the cycle of recurring headaches may be broken by the administration of small doses of corticotropin (ACTH). In two cases of this type headaches were controlled with 15 units of the drug given intravenously, followed by the routine vasodilators. Apparently, making the patient hyperadrenal is what breaks the cycle.

Dr. Hansel closed the discussion by recalling that in former years, prior to recognition of histamine cephalalgia cocainization of the sphenopalatine ganglion was very popular and often did afford relief. He has also used the sublingual histamine treatment. The dose should be about 10 times that by the subcutaneous route. Dr. Rawlins' comment about the effect of corticotropin seems logical because of the probable influence of the endocrine glands in these conditions.

Precision Bronchology: A Must in Thoracic Surgery. Dr. Robert E. Priest, Minneapolis.

With the increasing interest in thoracic surgery, accurate bronchology becomes more and more important in diagnosis and surgical indications. A systematic study of the 10 major branches of the tracheobronchial tree, often with the help of the newer telescopic scopes, will enable the endoscopist to pinpoint the pathology to the particular lung segment involved. Specimens obtained for pathologic and bacteriologic study must be ascribed to as localized an area as possible. The lesion can often be located exactly by measurements with a device shown that reveals the diameter of the bronchus at any level. Bronchograms are of great value if properly taken. This calls for the full cooperation of the anesthesia department, especially when children are concerned.

DISCUSSION

Dr. Edwin N. Broyles endorsed the thesis of precision in bronchology and added that it is important for the surgeon to know just what the various bronchi look like in a routine examination as well as to have the exact location of a lesion determined. Dr. Priest's presentation of typical bronchograms of children was very impressive.

Dr. D. E. Staunton Wishart was happy to note Dr. Priest's success with his method in children. He would certainly recommend it in situations in which possible fire hazards would prohibit the procedure which he, Dr. Wishart, has been employing in the new Children's Hospital of Toronto.

Dr. Paul H. Holinger believes that the nature of the report of the bronchologist to the surgeon is of prime importance. This calls for a terminology that is understood by both and may properly be the subject of mutual discussion among groups interested in all phases of thoracic diagnosis.

Dr. Louis H. Clerf agreed that accuracy is necessary in reports of any type of examination. As has been stated, it is necessary to describe the areas inspected and not to report merely "bronchoscopy negative." Also, when specimens are taken for sectioning or for cytologic study, it is vital that each specimen be properly labeled as to its point of origin.

Dr. Frank Turchik reported the value of bronchoscopy postoperatively in which obstruction due to an accumulation of previously instilled iodized oil (Lipiodol) was diagnosed and removed.

Dr. Priest stated that the work he described was performed exclusively in a private hospital, which should dispel the notion that it is possible only in a university hospital. Concerning diagnosis by biopsy, he feels that one should always include aspiration and smears, which should be done before the application of the biopsy forceps.

Surgical Complications of Diverticulum of the Pharynx. Dr. Kenneth A. Phelps, Minneapolis.

Dr. Phelps gave a brief history of the study of diverticulum of the pharynx and presented an analysis of 22 cases. The complications ensuing were as follows: stricture, one; recurrence, two; chest complications, three; and vocal cord paresis, two. In one case there was a failure to locate the sac. Small sacs are easier to operate on than large ones, and the esophagoscope was found to be helpful. Vocal cord paralysis can be prevented by early diagnosis and operation before the sac becomes enlarged. Also helpful are the elimination of the feeding tube after a few days and the feeding of the patient intravenously.

The complications encountered as mentioned above were thoroughly discussed.

DISCUSSION

Dr. Chevalier L. Jackson has found the esophagoscope very helpful, having gone back to using it after an unpleasant experience in which it had not been used. It is of value in locating the esophageal channel and in aspirating the contents of the sac before it is amputated. The scope is removed after marker sutures have been inserted in the upper and lower poles. If left in place, it makes the operation more difficult because it holds the neck of the sac deeply in the wound.

Dr. Atkins reported a case in which the patient was unable to swallow. A gastrostomy was performed, and the patient's strength was built up until dilatation of the upper esophagus could be accomplished prior to performing the resection. The operation was successful, but when ulcers developed in the pharynx and later in the cornea, it was discovered that the patient was suffering from pemphigus. Whether this had anything to do with the preoperative dysphagia is a matter of speculation.

Dr. Walter B. Hoover is convinced that the feeding tube is very necessary. Certainly a fistula will not heal if continually contaminated with food particles. He believes that the feeding tube will prevent a fistula or hasten the healing of it, if it occurs. It certainly is an added precaution in his experience. A point in diagnosis worth mentioning is that when using contrast media to locate and outline the sac, if a filling defect appears, one must not assume it to be due to foreign material. Such a case demands direct inspection and biopsy because, occasionally, the site of a carcinoma may be revealed.

Dr. Fred Havens reported that he observed such a case in which the sac was removed and, when sectioned, proved to contain a carcinoma.

Dr. Phelps was satisfied that postoperative infection is being effectively controlled and is no longer a problem. However, the other complications still appear in a certain percentage of cases, and he is of the opinion that they can be minimized, especially the chest complications, by eliminating the feeding tube as soon as possible.

Realism in Surgery of the Tonsils and Adenoids. Dr. Charles D. Blassingame, Memphis.

After a brief historical sketch of tonsil and adenoid surgery, Dr. Blassingame discussed the importance of completeness without damage to the pillars and other important structures. The lingual tonsils should be removed by scissors dissection and a snare. Adenoid surgery is unsatisfactory in many cases because of poor visualization. He advises following the LaForce with punch forceps and utilizing the Yankauer speculum for exposure. As a rule, one will find tissue in the lateral recesses which might ordinarily be missed. Tissue behind the tubal orifice can be exposed by using the speculum to displace the cartilage of the tube. Dr. Blassingame made a plea for more careful instruction of senior interns in this technique.

DISCUSSION

Dr. Walter B. Hoover agreed with Dr. Blassingame in the necessity of more thorough instruction of senior interns. He inquired of Dr. Blassingame as to what he does about the lateral pharyngeal bands and scattered nodules in the pharynx.

Dr. Blassingame replied that he had stated that a complete operation means not only removing the tonsils and adenoid masses but also removing the lingual tonsils and all secondary lymph nodules that can be nipped off with the triangular basket-type forceps.

Abstracts from Current Literature

Ear

THE TREATMENT OF DEAFNESS BY PROSTHESIS. H. G. KOBRAK, Ann. Otol. Rhin. & Laryng. **61**:1053 (Dec.) 1952.

When the eardrum and parts of the ossicular chain are destroyed by disease or surgery, with resultant conductive deafness, it is possible to bring about significant gains in hearing by the application of prostheses to the eardrum or tympanic cavity.

There are three types of prostheses: (1) the eardrum prosthesis, which covers the perforation in the drum membrane; (2) a tympanal prosthesis, which is placed in the niche of the round window or the oval window or against a surgical fenestra, and (3) the ossicular prosthesis, which replaces the destroyed eardrum and ossicular chain in the form of a rubber diaphragm with a rod attached which contacts the stapes, round window, fenestra, or other "trigger point."

Latex rubber is a favorable material for making an eardrum prosthesis and, when applied accurately and aseptically, will produce an improvement in hearing of 30 db. for some frequencies. It probably acts by restoring the hydraulic ratio of the sound-conduction system, although this effect needs further clarification through biophysical experiments, according to Kobrak.

The tympanal prosthesis is useful in ears with extensive eardrum and ossicular chain destruction, such as the type found in the radical mastoid cavity. A cotton pellet soaked in oil is the material frequently used, and it is best positioned in the niche of the round window. Its mechanism of action is not clearly understood, but it is believed that moisture is the acoustically important ingredient and that a skeleton of cotton fibers or a plastic tube to maintain the position and shape of the moisture is essential. Kobrak has found that a cholesterol-petrolatum (Aquaphor) ointment is nonirritating and has the advantage of absorption of moisture. This can be introduced by the patient by dropping sterile isotonic sodium chloride solution at body temperature into the ear when needed. The ointment can be left in the ear for weeks or months without irritation, but, notwithstanding this, it is well for the patient wearing a prosthesis to visit the otologist regularly.

The ossicular prosthesis of Pohlman is constructed like the columnella of a bird's ear and is physiologically sound. However, the difficulties in manufacturing, fitting, and maintaining the diaphragm rod mechanism are a drawback.

STEELE, Kansas City, Kan.

A CONTROLLED COMPARISON OF THE EIGHTH NERVE TOXICITY OF STREPTOMYCIN AND DIHYDROSTREPTOMYCIN. WALTER E. HECK, WILLIAM J. LYNCH, and HAROLD L. GRAVES, Ann. Otol. Rhin. & Laryng. **62**:101 (March) 1953.

Heck and his associates compared therapeutic and neurotoxic effects of streptomycin and dihydrostreptomycin in 68 tuberculous patients. No therapeutic advantage over the other could be attributed to either drug.

It was established that streptomycin is more likely to produce vestibular toxicity, while dihydrostreptomycin shows a tendency to produce auditory toxicity. Vestibular dysfunction becomes manifest soon after the onset of streptomycin therapy and is reversible on stopping use of the drug within a 120-day period of the administration of 1 gm. a day. Auditory dysfunction becomes apparent only after three to four months of dihydrostreptomycin therapy, is progressive for several months even though use of the drug is stopped, and is irreversible. The authors state that the factor of reversibility may hinge on the primitive resistant nature of the vestibular apparatus as compared to the newer, delicate auditory mechanism.

STEELE, Kansas City, Kan.

THE GAIN IN HEARING AFTER THE FENESTRATION OPERATION, AND ITS INFLUENCE UPON THE SURGEON'S CHOICE OF CASE. WILLIAM MCKENZIE, J. Laryng. & Otol. **66**:211 (May) 1952.

The suitability of candidates for fenestration surgery as determined by pure tone audiometry is discussed. The conclusions reached by McKenzie are in accord with those held by most fenestration surgeons and previously discussed by many authors. McKenzie feels that pregnancy is no contraindication to the fenestration operation in a suitable candidate.

LEJEUNE and LEWIS, New Orleans.

REPORT OF 15 CASES OF AGENESIS OF THE EXTERNAL AUDITORY CANAL. J. M. TATO, J. A. BELLO, and J. L. CASTELLANO, Acta oto-rino-laring. ibero-am. (No. 2) **4**:85, 1953.

Tato and his associates discuss both unilateral and bilateral agenesis of the external canal. They believe that an operation should be performed in cases of bilateral agenesis when the patient is 3 or 4 years old, so that the benefits of hearing may be associated with the development of the intellect, language, and education. Early treatment is most important. In cases of unilateral agenesis the physician may temporize. In cases of bilateral agenesis it is important to operate in order to (*a*) favor stereoacusia; (*b*) prevent deafness; (*c*) avoid possible intracranial complications; (*d*) solve the esthetic and psychologic problems of the patient and (*e*) prepare a useful cavity should a hearing aid be necessary in later life. The surgical technique is divided into three portions: (*a*) a bony procedure, namely, a complete mastoidectomy; (*b*) fenestration, and (*c*) the insertion of a skin graft in the form of a finger of a glove. The results in 15 cases are reported, revealing a marked improvement in hearing in a majority of the patients.

PERSKY, Philadelphia.

CONSIDERATION AND CAPITAL ASPECTS OF AUDIOMETRY. ERNESTO RAFFO, T. PONCE, L. VINATEA, and L. PARODI, Rev. peruana otorrhinolaring. y oftal. (No. 4) **11**:24 (July-Dec.) 1953.

Raffo and his associates present a comprehensive discussion of the various hearing tests and audiometry, with an interpretation and findings. They also discuss, in addition to pure tone audiometry, speech interpretation, describing the technique of all tests in considerable detail. Finally they discuss both pure tone and speech findings in a series of pathologic conditions, such as acute tubal obstruction, acute otitis media, otosclerosis, Ménière's syndrome, acoustic neuritis, and syphilitic deafness.

PERSKY, Philadelphia.

Pharynx

THE HYOID APPARATUS OF THE ALBINO RAT. E. L. HOUSE, Anat. Rec. **113**:81 (May) 1952.

In order to understand the development of the pharyngeal musculature more thoroughly, House undertook the study of the hyoid bone in the albino rat. He states that complete knowledge of any muscle, or group of muscles, involves the question of origin and insertion, which, in turn, entails knowledge of the skeletal structure. House found that the typical styloid process was absent in the albino rat; this is not surprising, as the absence of the styloid process is widespread among animals. There follows a minute description of the hyoid cartilaginous structure, which is composed of a body and two pairs of cornua. This article is the first of a series to be used as a background for a subsequent study of the development of pharyngeal musculature.

LEJEUNE and LEWIS, New Orleans.

CYSTIC TUMORS OF THE MAXILLA. PEDRO HOUNIE, An. oto-rhino-laring. Uruguay **22**:87, 1952.

In a detailed discussion as to the origin of the various types of maxillary cysts of dental origin, Hounie presents a series of 20 cases—13 of dental cysts involving the superior maxilla and 7 the inferior maxilla. He discusses the various methods of development, diagnosis, roentgen findings, and his surgical technique. Malignant degeneration was present in three of his cases. In addition, there were two cases of adamantinoma and one case of a hyatid cyst.

PERSKY, Philadelphia.

Larynx

PRELIMINARY REPORT ON AN APPLICATION OF THE MOTOR FUNCTION OF THE SUPERIOR LARYNGEAL NERVE. NEWTON D. FISCHER, Am. Otol. Rhin. & Laryng. **61**:352 (June) 1952.

Fischer observed the effect of section of the superior and recurrent laryngeal nerves in anesthetized dogs. The vocal cords were observed through the laryngoscope.

Section of both recurrent laryngeal nerves was followed by bilateral adduction of the cords. Simultaneous bilateral faradic stimulation of that portion of the superior laryngeal nerve supplying the cricothyroid muscles was followed by blanching, tensing, elongation, and further adduction of the cords.

Section of both recurrent laryngeal nerves and the branch of the right superior laryngeal nerve supplying the cricothyroid muscle was followed by adduction on the left, while on the right side, on which the motor division of the superior laryngeal nerve had been divided, the vocal cord was in the so-called "cadaveric" position. A satisfactory glottic chink and fair bark from the dog resulted.

Fischer is now studying the action of the motor division of the superior laryngeal nerve in the human subject. If it can be demonstrated that the human shows a reaction similar to that of the dog in this regard, the method used in the above study may be of use in the correction of bilateral abductor paralysis of the larynx in place of the various operations currently in use.

STEELE, Kansas City, Kan.

AN ENDOTRACHEAL METALLIC PROSTHESIS IN THE TREATMENT OF STENOSIS OF THE UPPER TRACHEA. W. B. HARKINS, Ann. Otol. Rhin. & Laryng. **61**:663 (Sept.) 1952.

Nobilium, a chromium-cobalt alloy, was used to fashion tubular tracheal implants in a series of dogs. The tubes remained in situ for periods varying from 2 to 85 days. In addition, a tube of this material was used in the trachea of one human patient for two successive six-month periods for treatment of long-standing tracheal stenosis.

When anchored in the canine trachea such a tube usually caused loss of superficial epithelium in the adjacent tracheal wall. The lumen of the tube was frequently narrowed but not obstructed by accumulation of dry mucus. Moderate inflammatory reaction in the trachea surrounding the tube was found. No gross evidence of chemical erosion of the alloy was noted after the six-month period.

In spite of the undesirable reactions, the nobilium tube served as an effective splint in the human patient, allowing the tracheal wall to heal around the tube after the obstructing scar tissue had been removed. The airway was satisfactory in all cases.

STEELE, Kansas City, Kan.

PROBLEMS IN DIFFERENTIAL DIAGNOSIS OF LESIONS OF THE LOWER PORTION OF THE ESOPHAGUS AND CARDIA. HERMAN J. MOERSCH, Ann. Otol. Rhin. & Laryng. **61**:976 (Dec.) 1952.

Moersch discusses a few of the problems involved in the differential diagnosis of lesions of the lower portion of the esophagus and cardia.

While the patient's history and a roentgenographic survey usually indicate the existence of cardiospasm, other esophageal lesions may closely resemble this condition. On bougienage, if the obstruction is pliable and can be overcome by gentle pressure, the physician is likely to be dealing with cardiospasm, Moersch states. On the other hand, if the obstruction is firm or hard, then the possibility of neoplasm should strongly be considered, especially if previous esophagoscopy has demonstrated no infiltration of the esophageal mucosa in the presence of partial obstruction at the cardia. Moersch reports that in about 10% of cases of carcinoma of the esophagus and in 25% of cases of carcinoma of the cardia his biopsies have been negative for malignant change. Cytologic examination of smears or secretions, however, somewhat increases the percentage of positive diagnoses.

In patients having diffuse spasm of the lower one-third of the esophagus, both passage of bougies and esophagoscopy will demonstrate obstruction in this area if topical anesthesia is used. If general anesthesia is employed, the obstruction will disappear.

The benign mucosal, intramural, or extramural neoplasm may be confused with cardiospasm if the patient's history and roentgenography alone are used for diagnoses.

Hiatal hernia frequently causes differential diagnostic difficulty due to its common association with ulcer of the esophagogastric juncture, which gives rise to esophagospasm. Also, hiatal hernia can be secondary to carcinoma, scleroderma, esophagitis, cicatricial structure or presence of a foreign body. Other diseases producing symptoms similar to those of cardiospasm are congenital esophageal anomaly, esophageal varix, tuberculosis, mycotic disease, and a post-traumatic change in the esophagus.

Six cases are reported.

STEELE, Kansas City, Kan.

STENOSIS OF THE ESOPHAGUS IN BENIGN MUCOUS MEMBRANE PEMPHIGUS. EDWARD B. BENEDICT and WALTER LEVER, Ann. Otol. Rhin. & Laryng. **61**:1120 (Dec.) 1952.

Benedict reviews five cases of benign mucous membrane pemphigus of the esophagus, which are recorded in the literature. He then presents four cases of his own.

A characteristic of this form of pemphigus, in contradistinction to pemphigus vulgaris, pemphigus foliaceus, and pemphigus vegetans, is its predilection for the mucous membranes. The tendency to produce scarring, its chronic benign course, and the subepidermal location of the bullae also typify this lesion.

The conjunctivae and the oral mucosa are more commonly involved than the esophagus. When involved, the esophagus is narrowed by web-like adhesions, which, if recognized early, can be treated satisfactorily by dilatation.

STEELE, Kansas City, Kan.

CONSERVATIVE TREATMENT OF CANCER OF THE LARYNX. I. SIMSON HALL, J. Laryng. & Otol. **67**:203 (April) 1953.

Hall suggests the classification of cancer of the larynx into anatomical, surgical, and radiotherapeutic stages. The anatomical stage classifies the growth as to the site of origin; the surgical stage, the spread of the disease, and the therapeutic stage, the development, extent, and involvement of other structures. For 10 years no curative surgery of the larynx was attempted. All patients with cancer of the larynx were referred for x-ray or radium irradiation therapy. Analysis of the results obtained by this type of treatment revealed that 10% of the patients survived for five years. During the next five years, surgery was included as a method of treatment for 37 patients. These patients showed a five-year survival rate of 35.1%. A description of the laryngofissure operation and the technique of radium application are presented. After further discussion of conservative therapy, the conclusion is reached that for a patient with limited cordal cancer surgery offers the best possibility of a cure.

LEJEUNE and LEWIS, New Orleans.

Nose

SOME OBSERVATIONS ON THE SURGERY OF THE MAXILLARY ANTRUM. A. R. DINGLEY, J. Laryng. & Otol. **67**:277 (May) 1953.

This article discusses the treatment and management of infections of the maxillary sinuses and the value of temporary drainage by repeated punctures or by the use of indwelling polyethylene tubes. If these methods prove unsuccessful, permanent drainage must be established either by intranasal antrostomy or by the performance of a Caldwell-Luc operation. The relative merits, techniques, and prognoses following these procedures are discussed, and a plea is made to respect nasal physiology.

LEJEUNE and LEWIS, New Orleans.

THE SURGICAL TREATMENT OF OZENA. EDUARDO LOLI and MANUEL LOLI, Rev. peruana otorrhinolaring. y oftal. (No. 3) **11**:18 (Jan.-June) 1952.

Eduardo and Manuel Loli discuss the anatomicopathologic relationship of ozena, its differential diagnosis, and treatment, both medical and surgical. In the medical treatment they use both stock and autogenous vaccines, permanent vasodilators, or estrogenic substances. The authors also include under this heading carotid sympathectomy. However, they feel that all medical

treatment is a long-drawn-out procedure and that the results are usually negative or indifferent. They recommend the surgical procedure which deals with the narrowing of the nasal chambers. In 15 patients they have used an autogenous fat implant. The fat is taken from the abdominal region and is inserted into the floor of the nose, subcutaneously and ascending laterally on the internal wall of the maxillary sinus. Usually the patient is without any discomfort during the postoperative period, and he is relieved of his frontal headaches and the foul odor. Loli and Loli feel that this method of treatment is superior to the use acrylic and that even though there is a reduction in the volume of the fat (in some cases as much as one-third), the patient still retains a certain amount of benefit or a permanent cure. Further observation in the metaplasia of the mucous membrane would be interesting in determining whether these autogenous implants can cause definite changes in the structure of the mucous membrane.

PERSKY, Philadelphia.

Miscellaneous

PLASMA CELL TUMORS OF THE MOUTH AND UPPER AIR PASSAGES. MAURICE R. EWING and FRANK N. FOOTE JR., Cancer **5**:499 (May) 1952.

In a comprehensive, instructional, and interesting article on plasma cell tumors occurring in the mouth and upper air passages, Ewing and Foote state that multiple myeloma is a progressive and fatal disease characterized by the presence of widely scattered tumors, mainly in the marrow of those adult bones in which hemopoiesis is most active. There follows an excellent description of these types of tumors. Although solitary plasma cell tumors arise most frequently from red bone marrow, it has long been known that similar tumors are occasionally found in soft tissues. In a review of the literature, only 97 cases were found reported from 1905 to 1947, and a series of 27 cases forms the basis of this study. Eighteen of the patients were males, and it was determined that the disease was commonest in patients above 50. The majority of these tumors were located in the nasal passages; early diagnosis was difficult, and nasal obstruction was the presenting symptom.

Ewing and Foote elected to classify these tumors into three groups: (1) solitary lesions of multiple myeloma; (2) solitary lesions confined to the soft tissues, and (3) solitary lesions with evidence of bone involvement. The tumors of the first and third groups were clinically alike and simulated cancerous lesions. Treatment consisted of surgery and irradiation, depending on the site, extension, and approachability of the lesion. The results obtained were not too good and forced a conclusion that the prognosis is exceedingly unfavorable in all of these cases. It is believed that it is unsafe to regard any of these lesions as noncancerous and that plasmacytoma should always be considered potentially malignant.

LEJEUNE and LEWIS, New Orleans.

A COMPLETE CLEFT PALATE PROGRAM. WAYNE B. SLAUGHTER and GRETCHEN MUELLER PHAIR, J. Speech. & Hearing Disorders **17**:123 (June) 1952.

For the past 17 years in the state of Wisconsin about 1 in every 770 infants born has had a cleft lip or palate which must be reported by the attending physician. Diagnosis is made at the University of Wisconsin Medical School. A social service interview is included in the medical examination. After surgery, a formal training of eight weeks is given these children, including hearing tests, psychometric studies, reexamination of the palate, etc. Satisfactory rehabilitation is a long-time program and must be continued until the child is a normal member of society.

PALMER, Wichita, Kan. [A. M. A. AM. J. DIS. CHILD.].

THE TREATMENT OF HEADACHES. MURRAY BRAAF and SAMUEL ROSNER, New York J. Med. **53**:687 (March 15) 1953.

This report is based on work done at the Lebanon, Mother Cabrini Memorial, and Stuyvesant Polyclinic Hospitals, New York City. Braaf and Rosner remind the reader that a headache is a symptom, not a disease. It is either extracranial or intracranial. History of trauma is important, and there may be a psychogenic origin but this is relatively rare. The general physical examination will include also encephalography and myelography when necessary. Ear, nose, and throat studies should be complete. Pressure is rightfully placed upon the cervical spine and all

adjacent muscles; the patient will often be surprised when "sore spots" are found, of which he has been completely unaware. Stiffness, rigidity, and tenderness are common. The eyes may be ptosed, and lacrimation, scotoma, photophobia, and hemianopsia may be seen. Rhinorrhea, turbinal swelling, and mouth breathing are common also. Coughing, sneezing, laughing, and straining at stool may induce or aggravate the head pains. X-ray findings seldom show pathology, unless there is a brain tumor, cerebral abscess or aneurysm. As to treatment, head traction by the Sayre apparatus is described in detail. This traction plus intramuscular injections of thiamine hydrochloride, 200 mg., into the gluteus muscles are "almost specific." The injections are given daily at first, then two to three times a week for many months. Intranasal sphenopalatine ganglion block (Sluder) for lower-half headache is very useful. Injection of 2% procaine hydrochloride into the upper cervical region gives immediate temporary relief. An intravenous injection of 10 cc. of 1% procaine hydrochloride gives dramatic temporary relief. The patient should be recumbent for 10 minutes because of possible dizziness. Histamine intravenously or subcutaneously, has limited use. Massage of the neck, certain exercises, diathermy, and physical therapy are useful adjuncts.

In general, the drug used was acetylsalicylic acid which is the common remedy used at home before the patient consults a physician. A combination of acetophenetidin and caffeine supplemented by cocaine is useful, and the barbiturates are much in vogue. In vascular cases ergotamine tartrate may be combined with caffeine and given orally or rectally, but it must be administered early during an attack in order to be effective. Meperidine (Demerol) hydrochloride, administered intramuscularly (50 to 100 mg.) should be given with caution because it is habit-forming.

It is so easy to offer a psychogenic cause, but there are relatively few patients, only 8%, in need of psychotherapy. The patient should not be stigmatized with this label needlessly, lest the physician actually produce the condition in the patient.

Surgery is rarely needed, except in disc cases in which removal is the only logical treatment. The technique is very special and should be well studied by x-ray and other methods (dyes) before the procedure is begun.

ABSTRACTOR'S COMMENT: This is an excellent article since it gives briefly the results in 500 cases which were well studied. Heretofore, insufficient stress has been placed on signs and symptoms in the neck. Doctors of medicine who practice osteopathy have reported their findings and have described methods of neck adjustments which I have known to be successful.

I. W. VOORHEES, New York

Books

Clinical Allergy. By French K. Hansel, M.D., M.S., Director, Hansel Foundation for Education and Research in Allergy; Chief of Allergy Service, DePaul Hospital, St. Louis. Price, $17.50. Pp. 1,005, with 86 illustrations (3 in color). C. V. Mosby Company, 3207 Washington Blvd., St. Louis 3, 1953.

The author has taken the occasion to rewrite a previous text in order to make a complete presentation on general allergy. There is much in this book to interest the general practitioner as well as the specialist. This is a new book, discussing new treatments. Although particular attention has been directed to the nose and paranasal sinuses, discussion of other structures has not been neglected. Particularly noteworthy are the five chapters which are devoted to the problems of allergy in infants and children. They are concerned not only with the respiratory and gastrointestinal tracts but also with the various skin conditions of allergenic origin. There are excellent discussions on cardiovascular allergy and the headache problem. The author discusses at great length his principle of the "Small or Optimum Dosage." The book is well documented by the author's personal experience and by voluminous references. The index is also comprehensive. There appears to be little in this book that is not worthy of attention. It is recommended to those interested in its subject matter.

Le mecanisme des machoires (naturelles et artificielles). By François Ackermann, Professor at the Institute of Dental Medicine of the University of Geneva. Price, 6,500 francs. Pp. 819, with 721 illustrations. Masson & Cie, 120 Saint-Germain Blvd., Paris 6e, 1953.

Despite the importance of this subject, no one book prior to this volume has been devoted to it in the French language. The author, basing his studies on the basic sciences, presents the problems encountered in the equilibration of the dental articulation, both natural and artificial. The subject matter is well covered in a well-written and organized manner. There are many excellent illustrations in black and white.

In covering the field the author has devoted the first four chapters to fundamentals, which comprise almost one-half of the book. In the fifth chapter, the author discusses the laws of levers and their relationship to the temporomandibular joint. The sixth and seventh chapters are concerned with dental prosthetics. The eighth chapter deals with medicosurgical considerations, and the last chapter is devoted to dynamics and bite analysis.

This book would be a welcome addition to any dental school library and would make a fine reference book for all those interested in human dentition.

Treatment of Resiratory Emergencies Including Bulbar Poliomyelitis. By Thomas C. Galloway, M.D., Professor Emeritus of Otolaryngology, Northwestern University Medical School; Attending Otolaryngologist, Evanston Hospital, Evanston, Ill. Price, $3.00. Pp. 94, with 5 illustrations. Charles C Thomas, Publisher, 301-327 E. Lawrence Ave., Springfield, Ill., 1953.

This monograph continues to maintain the high level of excellence that is to be found in all the American Lectures in Otolaryngology, Audiology, and Broncho-Esophagology Series. The author discusses his subject matter in an authoritative, concise, and readily understood language. The contents are systematically arranged as follows: (1) introduction; (2) mechanics of respiratory obstruction; (3) anoxia in clinical states; (4) acute bulbar poliomyelitis; (5) tracheotomy, and (6) tracheotomy in other diseases with obstruction. There is a brief but comprehensive bibliography at the end of the book. Since the subject matter is gaining increasing importance and the author's viewpoints are worthy of attention, this book is recommended.

The 1952 Year Book of Eye, Ear, Nose & Throat. Edited by Derrick Vail, B.A., M.D., D.Oph.(Oxon), Professor and Director, Department of Ophthalmology, Northwestern University Medical School, and Johin R. Lindsay, M.D., Professor of Otolaryngology, University of Chicago School of Medicine. Price, $6.00. Pp. 455, with 120 illustrations. Year Book Publishers, Inc., 200 E. Illinois St., Chicago 11, 1953.

This new annual year book, as its predecessors, is packed with most of the significant advances in diagnosis and treatment which were published in the period from October, 1951, to September, 1952. The editors have continued the original design of the book which had as its goal a method to keep physicians up to date despite their limited reading time. The synopses are only a thumbnail presentation of the articles selected and should not be considered a complete substitution for reading the original publications. This little handbook is packed from cover to cover with information, some of it more important than the rest. The editorial comments are pithy and to the point. This is a book that the practitioner will have occasion to refer to time and again.

The Pharynx: Basic Aspects and Clinical Problems. Edited by Abraham R. Hollender, M.D., F.A.C.S., Professor Emeritus of Otolaryngology, University of Illinois College of Medicine; Attending Otolaryngologist and Chairman of the Service, Mount Sinai Hospital of Greater Miami, Fla. Price, $15.00. Pp. 573, with 156 illustraions. Year Book Publishers, Inc., 200 E. Illinois St., Chicago 11, 1953.

This volume has been written by authors well qualified to discuss the various aspects of the pharynx. It is fortunate that the editor has selected collaborators of sufficient experience to make the general tone of the book a highly recommended text. The contents of the book have been arranged in two sections—"Basic Aspects" and "Clinical Problems." "Clinical Problems" deals with the following topics: (1) "Epipharynx"; (2) "Oropharynx"; (3) "The Uvula, Salivary Glands, and Neck"; (4) "Tuberculosis, Syphilis, Neoplasms," and (5) "Miscellaneous Considerations." Each chapter has its own editorial comment and bibliography. The index is adequate. As a guide to and as a discussion of all phases of pharyngeal disorders, this book is recommended for the viewpoints it presents and might well be read by all interested practitioners.

Oral Anatomy. By Harry Sicher, M.D., D.Sc., Professor of Anatomy and Histology, Loyola University School of Dentistry; Chicago College of Dental Surgery. Second edition. Price, $13.50. Pp. 529, with 310 illustrations. C. V. Mosby Company, 3207 Washington Blvd., St. Louis 3, 1952.

This book, although written primarily for students of dentistry, is, however, of interest to all those concerned with the subject of oral anatomy. Intended as a supplement to standard texts of anatomy, its descriptive passages have been simplified, while greater emphasis has been placed on practical and functional considerations. This has been accomplished to great advantage. Illustrations are abundant and instructive.

The book is divided into two parts. The first deals with descriptive anatomy; the second, with regional and applied anatomy. The temporomandibular articulation has been especially carefully considered. A particularly informative chapter is presented on topographic anatomy as applied to the techniques of local anesthesia. A review is given of approaches to arterial ligations and other surgical procedures (i. e., tracheotomy). While this is too brief from the surgeon's point of view, it is more than adequate for the student's understanding. An excellent index has been provided.

Advances in Otorhinolaryngology. Vol. 1 in German. Edited by L. Rüedi and collaborators, M. Arslan, Padua; L. B. Jongkees, Amsterdam, and E. Wodak, Tel-Aviv. Cloth. Price, 36 Swiss francs. Pp. 263, with 49 illustrations. S. Karger, Holbeinstrasse 22, Basel, Switzerland, 215 Fourth Ave., New York 3, 1953.

This volume deals with the vestibular apparatus. Jongkees discusses many of the newer theories of the vestibular function and the physiology of the vestibular organ. He also outlines the significance of both normal and pathologic reactions to the various forms of stimulation.

Arslan presents a chapter on methods of vestibular examinations and a recommendation for standardization of all prevailing methods of testing the vestibular apparatus. Wodak discusses the physiopathologic problems and presents many case reports and the interpretation of abnormal findings from the standpoint of differential diagnosis of both peripheral and central lesions, with a considerable discussion of Ménière's Syndrome. This book, replete with many references, is unquestionably a very comprehensive evaluation of our present knowledge of the vestibular organ.

Oral Surgery. By Kurt H. Thoma, D.M.D. Second edition. Price, $30.00. Pp. 1688, 2 volumes, with 1,789 illustrations, including 121 in color. C. V. Mosby Company, 3207 Washington Blvd., St. Louis, 3, 1952.

This is the first revision by Dr. Thoma of his classic work in oral surgery. In keeping with advances made since World War II, he has added new chapters on the use of chemotherapy and antibiotics. The treatments for acquired jaw defects and surgical deformities have been grouped together in a separate section. Recent advances in local and general anesthesia have also warranted a separate chapter.

The first four chapters of the book, dealing with the principles of surgery, general care of the patient, anesthesiology, and antibiotics, seem overly simplified. However, since the author expressly intended this book primarily for undergraduate dental students and general practitioners of dentistry and medicine, this is justified. He has made a wise decision in omitting general pathological discussion, referring his readers to "Oral Pathology."

Numerous case histories and illustrations are used to great advantage. The detailed descriptions of surgical procedures make this a very important book to all dentists and to physicians who work in or about the mouth. The account of the ingenious methods of fixation of fractures of the jaw and facial bones is both interesting and stimulating.

The quality and quantity of the illustrations cannot be praised too highly.

As in the first edition, Dr. Thoma has not attempted to describe several operations for each condition, but he has minutely and accurately described the procedure that has been most successful in his hands. The bibliography has been brought up to date and should prove to be valuable as a reference guide.

Ménière's Disease. By Henry L. Williams, M.D., M.S. in Otology. Price, $7.00. Pp. 349, with 15 illustrations. Charles C Thomas, Publisher, 301-327 E. Lawrence Ave., Springfield, Ill., 1952.

This excellent book is a critical review and digest of all the confused thinking and literature on Ménière's disease. Starting with a clarification of Ménière's original concept, the author describes the anatomy, physiology, and pathology of the labyrinth as related to Ménière's disease. The following chapters discuss etiology and diagnosis. A large chapter is devoted to allergy and autonomic dysfunction. This is followed by chapters on medical and surgical treatment and a very definitive recapitulation.

Although there are many conflicting concepts discussed in the book, the author has crystallized his thinking very clearly on the basis of considerable clinical experience. Each chapter is followed by an extensive and up to date bibliography. Although a number of the author's opinions still lack confirming evidence, they are forthrightly and logically derived. The book is worth reading and offers an excellent perspective on Ménière's Disease.

Directory of Otolaryngological Societies *

FOREIGN AND INTERNATIONAL

Canadian Otolaryngological Society
(Société Canadienne d'Otolaryngologie)

President: Dr. D. E. S. Wishart, 170 St. George St., Toronto.
Secretary: Dr. W. Ross Wright, 361 Regent St., Fredericton, N. B.
Place: Minaki Lodge, Minaki, Ont. Time: June 14-18, 1953.

Fifth International Congress of Oto-Rhino-Laryngo-Broncho-Esophagology

Place: Amsterdam. Netherlands. Time: June 8-13, 1953.
President: Prof. Dr. Eelco Huizinga.
General Secretary: W. H. Struben, Viottastraat 1, Amsterdam-Z
Scientific Secretaries: Dr. J. Bijtel and Dr. P. G. Gerlings.

International Bronchoesophagological Society

President: Dr. Andre Soulas, Paris, France.
Secretary: Dr. Chevalier L. Jackson, 1901 Walnut St., Philadelphia 3.
Meeting: Third International Congress of Bronchoesophagology.
Place: Lisbon, Portugal. Time: September or October, 1954.

International Congress of Audiology

Place: Leyden, Netherlands. Time: June 5-6, 1953.
General Secretary: Dr. H. C. Huizing, 182 Oostersingel, Groningen, Holland.

International Course in Paedo-Audiology

Place: Groningen, Netherlands. Time: June 1-4, 1953.
General Secretary: Dr. H. C. Huizing, 182 Oostersingel, Groningen, Holland.

Pan American Association of Oto-Rhino-Laryngology and Broncho-Esophagology

Meeting: Fourth Pan-American Congress of Oto-Rhino-Laryngology and Broncho-Esophagology.
Place: México, D. F., Mexico. Time: Feb. 28-March 4, 1954.
President: Dr. Justo Alonso.
Exec. Secretary: Dr. Chevalier Jackson, 1901 Walnut St., Philadelphia 3.
President of Congress: Dr. Ricardo Tapia Acuna.

Third Latin-American Congress of Otorhinolaryngology and Bronchoesophagology

Place: Caracas, Venezuela. Time: Feb. 21-25, 1954.

NATIONAL

American Medical Association, Scientific Assembly, Section on Laryngology, Otology and Rhinology

Chairman: Dr. Dean Lierle, Iowa City.
Secretary: Dr. Sam H. Sanders, 1089 Madison Ave., Memphis 3.
Place: San Francisco.

American Academy of Ophthalmology and Otolaryngology

President: Dr. James Milton Robb, 315 Lakeland Ave., Grosse Pointe 30, Mich.
Executive Secretary-Treasurer: Dr. William L. Benedict, 100-1st Ave. Bldg., Rochester, Minn.
Place: Palmer House, Chicago. Time: Oct. 11-17, 1952.

* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.

American Board of Otolaryngology

President: Dr. LeRoy A. Schall, 243 Charles St., Boston.
Secretary-Treasurer: Dr. Dean M. Lierle, University Hospitals, Iowa City.
Place: Statler Hotel, Boston. Time: May 10-15, 1954.

American Broncho-Esophagological Association

President: Dr. Edwin N. Broyles, 1100 N. Charles St., Baltimore 1.
Secretary: Dr. F. Johnson Putney, 255 S. 17th St., Philadelphia 3.
Place: Statler Hotel, Boston. Time: May 25-26, 1954 (afternoons only).

American Laryngological Association

President: Gordon F. Harkness, 215 Main St., Davenport, Iowa
Secretary: Dr. Harry P. Schenck, 326 S. 19th St., Philadelphia 3.
Place: Statler Hotel, Boston. Time: May 20-21, 1954.

American Laryngological, Rhinological and Otological Society, Inc.

President: Dr. LeRoy A. Schall, 243 Charles St., Boston.
President-Elect: Dr. Kenneth M. Day, 121 University Place, Pittsburgh.
Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester 7, N. Y.
Place: Statler Hotel, Boston. Time: May 25-27, 1954.

SECTIONS:

Eastern.—Chairman: Dr. Daniel S. Cunning, 118 E. 53rd. St., N. Y. 22.
Place: Hotel Syracuse, Syracuse, N. Y. Time: Jan. 7, 1953.
Southern.—Chairman: Dr. William C. Wolfe, 332 W. Broadway, Louisville 2.
Place: Andrew Jackson Hotel, Nashville, Tenn. Time: Jan. 12, 1953.
Middle.—Chairman: Dr. French K. Hansel, 634 N. Grand Blvd., St. Louis 3.
Place: The Drake, Chicago. Time: Jan. 19, 1953.
Western.—Chairman: Dr. Guy L. Boyden, 1735 N. Wheeler Ave., Portland 12, Ore.
Place: The Elks Club, Los Angeles. Time: Jan. 24, 1953.

American Otological Society, Inc.

President: Dr. Frederick T. Hill, Professional Building, Waterville, Maine
Secretary-Treasurer: Dr. John R. Lindsay, 950 E. 59th St., Chicago.
Place: Statler Hotel, Boston. Time: May 16-17, 1954.

American Otorhinologic Society for the Advancement of Plastic and Reconstructive Surgery, Inc.

President: Dr. Harry Neivert, 555 Park Ave., New York 21.
Secretary: Dr. Louis Joel Feit, 66 Park Ave., New York 16.

American Society of Ophthalmologic and Otolaryngologic Allergy

President: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
President-Elect: Dr. Albert D. Reudemann, 1633 David Whitney Building, Detroit 26.
Secretary-Treasurer: Dr. Michael H. Barone, 468 Delaware Ave., Buffalo 2.
Place: Palmer House, Chicago. Time: Oct. 16, 1953.

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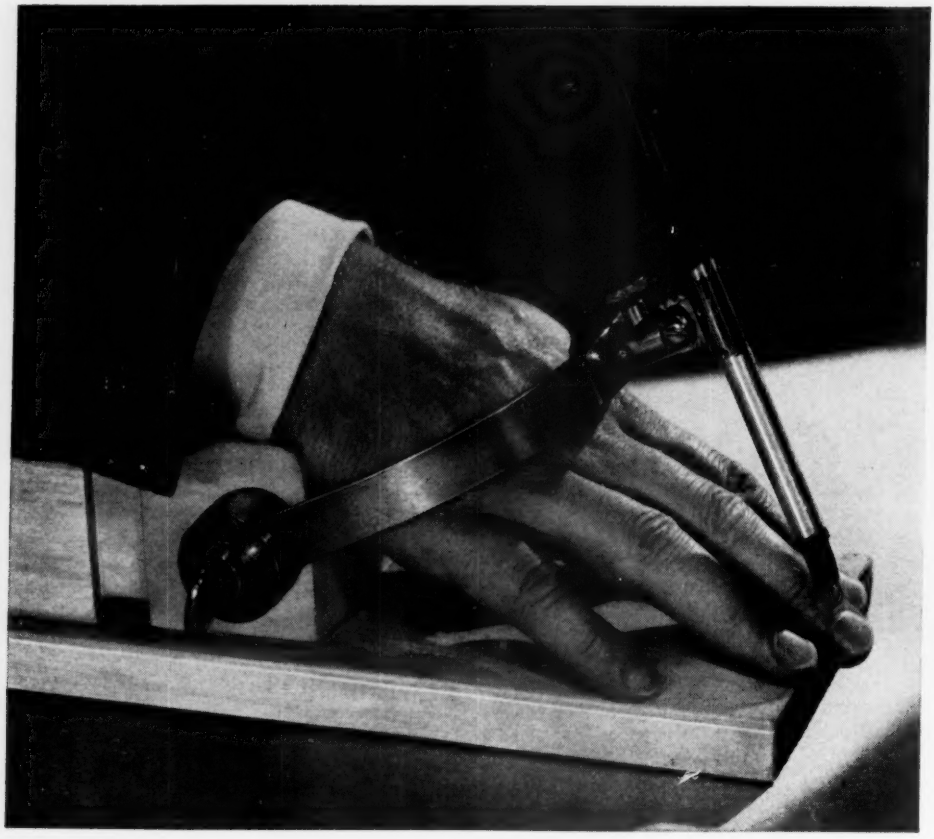

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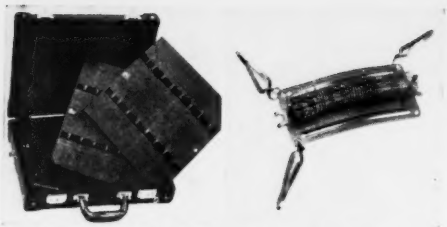

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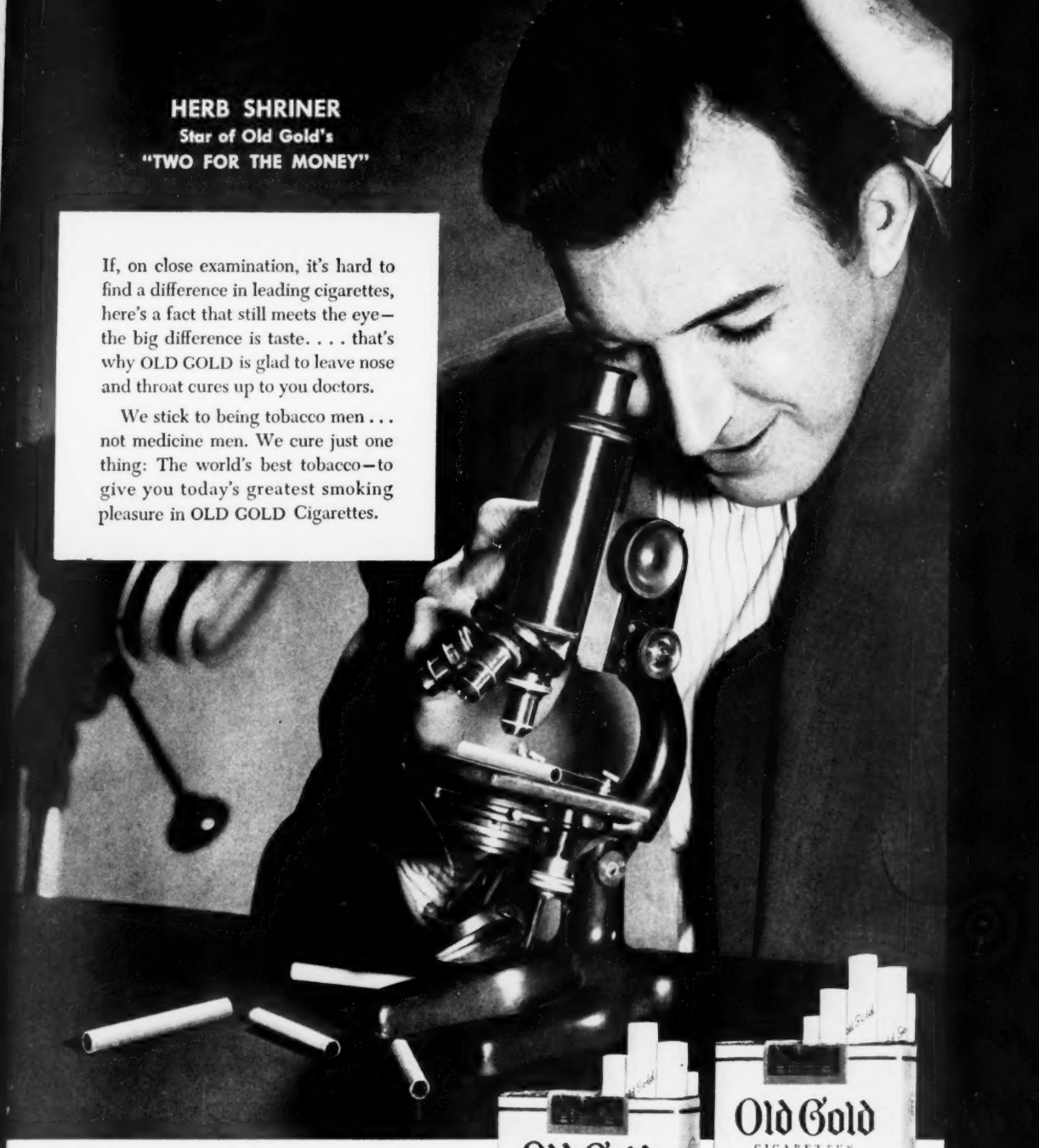

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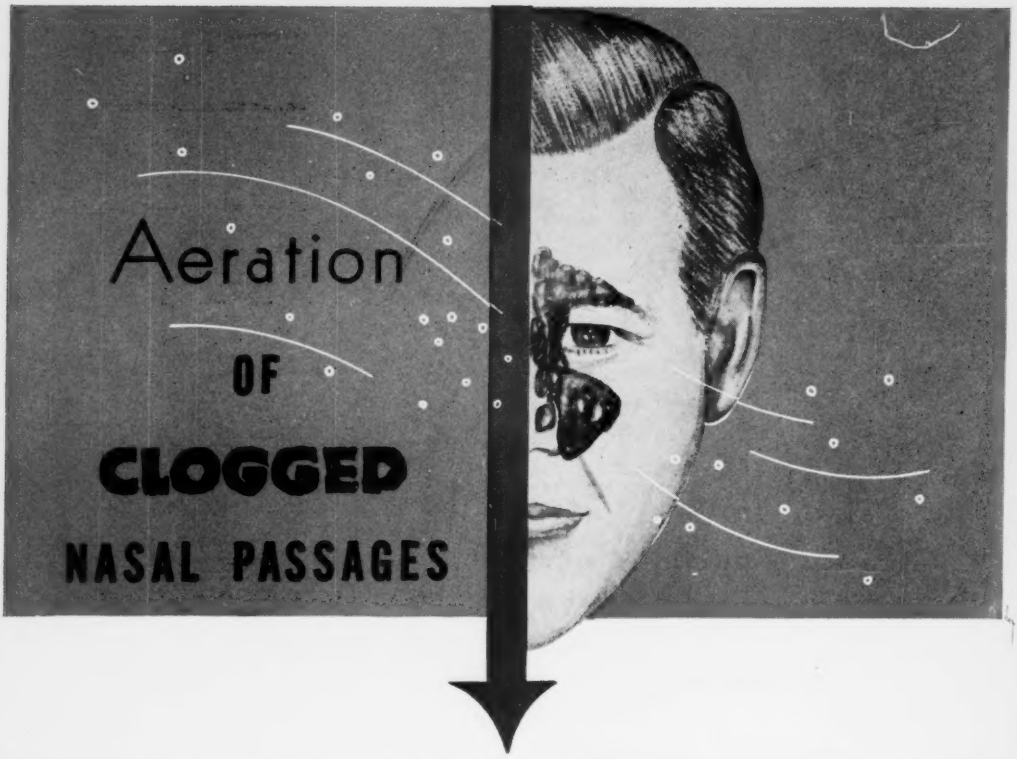

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WELL TOLERATED — Neo-Synephrine is notable for its relative freedom from sting, virtual absence of compensatory congestion and also has been found relatively free from systemic side effects such as nervous excitation, cardiac reaction or insomnia even when tested on hypertensive, cardiac and hyperthyroid patients.[1]

NO APPRECIABLE INTERFERENCE WITH CILIARY ACTIVITY — Neo-Synephrine not only restores nasal patency, but is compatible with ciliary action.

NO DROWSINESS — Neo-Synephrine may be used by the ambulatory patient without danger of producing drowsiness or related sedative action. Applied topically, Neo-Synephrine confines its action to the upper respiratory passages.

SUPPLIED:

0.25% solution (plain), 1 oz., 4 oz. and 16 oz. bottles.

0.25% solution (aromatic), 1 oz. and 16 oz. bottles.

0.5% solution, 1 oz. bottles.

1% solution, 1 oz., 4 oz. and 16 oz. bottles.

0.5% water soluble jelly, ⅝ oz. tubes.

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Neo-Synephrine, trademark reg. U.S. & Canada, brand of phenylephrine

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1. Van Alyea, O. E., and Donnelly, Allen: Arch. Otolaryng., 49:234, Feb., 1949.

WINTHROP-STEARNS INC. • New York 18, N. Y. • Windsor, Ont.